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# TNT Maritime Interdiction Operation Experiments: Enabling Radiation Awareness and Geographically Distributed Collaboration for Network-Centric Maritime Interdiction Operations



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12TH ICCRTS  
ADAPTING C2 TO THE 21<sup>ST</sup> CENTURY

**Topic: TNT Maritime Interdiction Operation Experiments: Enabling  
Radiation Awareness and Geographically Distributed Collaboration for  
Network-Centric Maritime Interdiction Operations**

Track 2 : Networks and Networking  
or  
Track 7: Network-Centric Experimentation and Applications

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**Abstract**

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The paper addresses technological and operational challenges of developing a global plug-and-play Maritime Domain Security testbed. This joint NPS-LLNL project, supported by partners from Sweden, Austria, and Singapore is based on the NPS Tactical Network Topology (TNT) comprised of long-haul OFDM networks combined with self-forming wireless mesh links to radiation detection sensors, and real-time radiation awareness collaboration with geographically distributed partners. In the center of our discussion are networking, sensor, and collaborative solutions for the Maritime Interdiction Operation (MIO) Experiments in which geographically distributed command centers and subject matter experts collaborate with the Boarding Party in real time to facilitate situational understanding and course of action selection. The most recent experiment conducted in the San Francisco Bay jointly with partners from Sweden, Singapore, and Austria proved feasibility and good potential of the proposed key technologies aimed at improving MIO.

In our discussion of TNT MIO Experiments, Dr. Alex Bordetsky presents TNT MIO Testbed, ship-to-shore and ship-to-ship networking solutions and collaborative technology for net-centric MIO.

Dr. Arden Dougan discusses experiences using radiation detection and explosives detection sensors during the experiments and the associated reachback from technical experts.

*Dr. Foo Yu Chiann elaborates on the TNT MIO node in Singapore and its role in the experiment....*


Singapore participated in the Experiment through a Virtual Private Network (VPN) connection established between the Defence Science and Technology Agency (DSTA) and NPS. Singapore not only observed the Experiment but also provided injects in the role of the shipping company that had unknowingly transported the radioactive cargo as part of its shipment.

Cdr. Anders Kilhberg elaborates on the TNT MIO testbed node in Southern Sweden and, it's role and the plans for unfolding collaboration with SNWC.

Swedish Naval Warfare Centre (SNWC) has participated in the TNT experiments since TNT 06-2 both as observers and as collaborators. Sweden participates through a Virtual Private Network (VPN) connection with is established at the Naval Warfare Centre in Karlskrona in the southern part of Sweden. Sweden acts as a counterpart Maritime



Security Organization (MSO) and will conduct Maritime Interdiction Operation (MIO) within the Baltic Sea. SNWC provides injects and live video feed into the network. Radiation data is posted in the collaboration tool for reachback organization to analyze. The long running aim with Sweden's participation in the TNT MIO testbed is to have a full scale, 2 day, experiment during fall 2008 under the heading "Wireless Broadband supporting Maritime Security in Littoral Waters". The aim with this experiment will be to set up an ad hoc network in an area in the Baltic sea supporting cooperation between the military and civil authorities (e.g. police, coast guard) solving attempt to smuggling (e.g. CBRN, people). To reach that goal Sweden will use the experiments as stepstones to try to fulfill that goal. For the next experiment in this series 07-2, we will try to test a CBRN sensor and communication jacket (prototype) and try to hook it up on the network.



## 1. Introduction

Since 2004 a joint team of Naval Postgraduate School and Lawrence Livermore National Laboratory researchers is operating a plug-and-play testbed, which enables discovery, integration, and demonstration experiments for a broad range of Maritime Interdiction Operation scenarios including mesh and long-haul wireless networking with radiation detection sensors, boarding party collaboration with remote expert teams, reachback to different locations around the globe.

The operational focus of NPS-LLNL experiments is on finding viable solutions for MIO connectivity and collaboration providing for rapid radiation awareness, biometrics identification, non-proliferation machinery parts search, and explosive materials detection on the board of the target vessel during the boarding party search phase

The testbed contains a tactical, OFDM 802.16 backbone, terminating in various locations within the 200 mi length in Northern California (Fig. 1), which provides for the ad hoc plug-in of UAVs, boats, ships, small SOF and Marine units, including airborne and ground self-forming mesh communications. It contains an expanding set of domestic and overseas remote command and tactical centers with global reach back capabilities and rapidly deployable self-forming wireless clusters (including student network operation services 24/7). The Maritime component being developed jointly with the Lawrence Livermore National Laboratory extends the testbed capabilities to ship-to-shore, ship-to-ship, ship-UAV (Unmanned Aerial Vehicle)-ship, ship-USV (Unmanned Surface Vehicle)-ship, and ship-AUV (Autonomous Underwater Vehicle), sensor mesh mobile networks (Fig. 2).

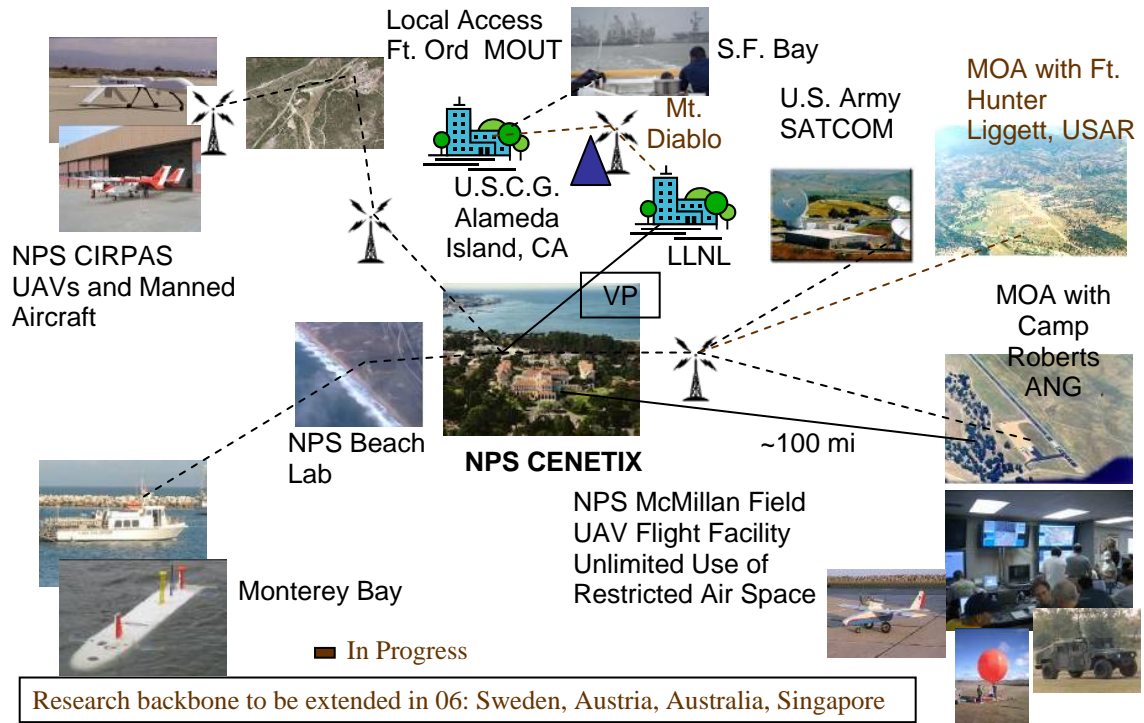


Figure1. Plug-and-Play TNT MIO Networking Testbed

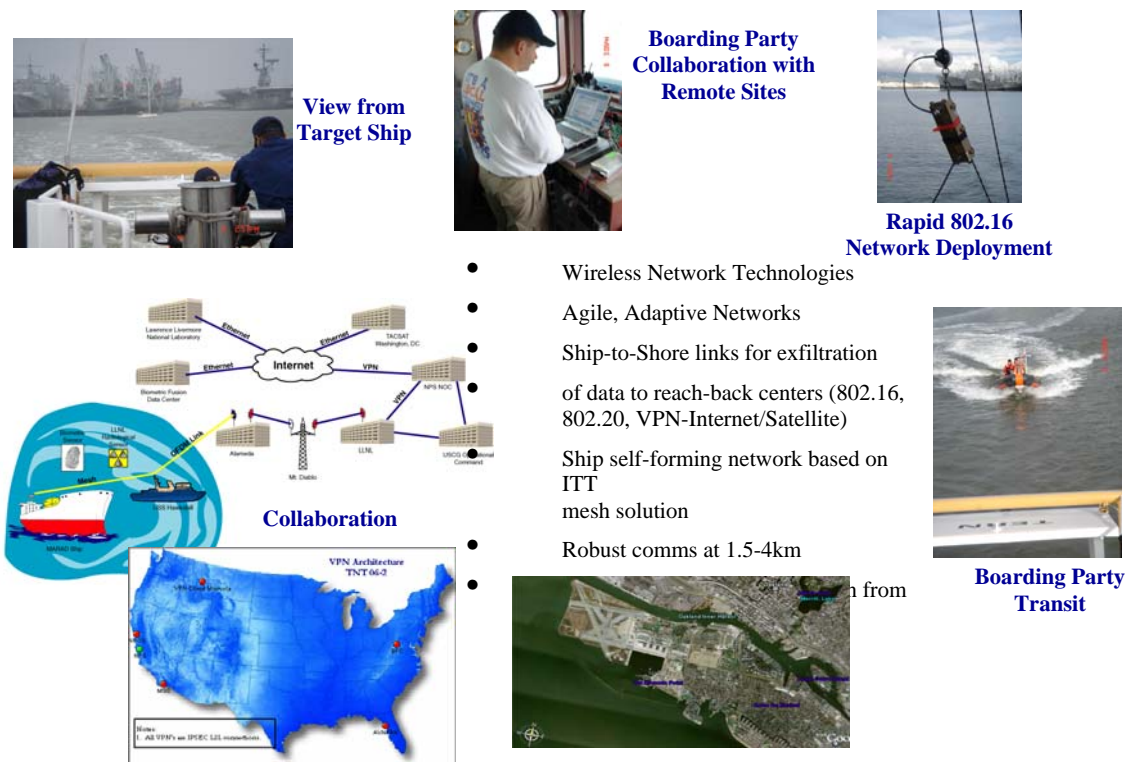


Figure 2. Testbed in Action During the MIO 06-2 Experiment

## **2. Typical Scenario for Maritime Radiation Awareness and Interdiction Experiments**

Over the course of 6 consecutive discovery and demonstration experiments the MIO scenario evolved into script which employs coordinated actions of multiple agencies and institutions involved in homeland security operations and especially those related to maritime interdiction, interception and control:

According to intelligence, a cargo vessel that departed country X in early February is carrying a terrorist cell with hazardous (radiological) material and is attempting to enter the country via a West coast port. The Vessel's name and port of arrival are unknown.

Multiple boarding operations are ongoing (and updates are posting to Maritime Intelligence Fusion Center - MIFC via E-Wall). Intel has updated information and has high confidence that a vessel entering Washington State has the terrorists onboard. Simulated deception event is that USCG and NSWC are coordinating the vessel's takedown and that is happening with updates to E-wall.

Under that course of action, USCG has ordered one of its vessels (simulated by MARAD SS Gem State) to stop, board, and search a ship (simulated by USCG Tern) suspected of transporting radiological material as well as a terrorist cell. In order to do that, while the suspect vessel is underway, a RHIB with a boarding team is employed.

Level I boarding team have conducted a search of the vessel due to its status as an HIV. They were equipped with RadPagers. During the inspection, a neutron alarm was triggered on a RadPager. The alarm was a constant alarm, not spurious counts. The level I team practiced SMAC and called in a Level II team to resurvey the ship with their additional radiation detection equipment. This is an LE mission.

So, in order to assist in locating suspects, uranium enriching equipment and explosives, the USCG Operations Center, Alameda has directed its Level II boarding team to employ radiation detection, explosives detection, and biometric equipment to help expedite this at-sea search. Since there are numerous commercial uses for certain radioactive sources and positive identification of the source in a short time is imperative, a network extension capability is utilized from the suspect vessel to the boarding team's launch vessel and ashore. This rapidly deployable, collaborative network is reaching back to LLNL and the Defense Threat Reduction Agency (DTRA) to assist in identification of suspect cargo. Support from the National Biometric Fusion Center must be used to quickly and accurately discriminate between actual vessel crewmembers and non-crew suspects.

The tasking for Level II boarding team is to conduct a survey of the cargo ship and identify the source of the neutron readings utilizing Radpager, identiFINDER and RadPack devices. Also, using biometrics recording devices, crew members must be taken their fingerprints and that biometrics data is to be to BFC for identification.

The expected boarding scenario events are the following:

- Hidden neutron source in engine room and hidden gamma source as cargo. BFC fingerprints Captain and crew.
- First gamma spectrum of gamma source taken is poorly done because the boarding party took too short of a spectrum. Reachback can ask for second spectrum for analysis). Gamma spectrum of neutron source and photos sent to reachback and export control for identification.
- Once the identification of the items is passed to the boarding team and fed to MIFC, the cognitive process clock starts where the experts work in collaboration with MIFC and USCG support vessel to understand the situation and come up with a course of action to deal with the threat.
- Once the captain of the ship is located, he can inform the boarding party that he had a soil density gauge that emitted neutrons (but only after we send spectra and photos of item).(Export control should identify it as soil density gauge.) Unfortunately it was stolen. The captain can't explain the gamma source- possible terrorist threat? Captain's fingerprints show him to be on a watch list.

The radiological material will be simulated by detection files that will provide the LLNL analysis team with some ambiguity about the severity of the material. Once that determination is passed to the boarding team and fed to MIFC, the cognitive process clock starts where the experts work in collaboration with MIFC, USCG and boarding team to understand the situation and come up with a course of action to deal with the threat.

### 3. Major Networking Segments of the TNT MIO Testbed

- A. **OFDM/802.16** mobile man-portable\_network extension connecting providing ship-to-shore and ship-to-ship broadband communications. Short for *Orthogonal Frequency Division Multiplexing*, an FDM modulation technique for transmitting large amounts of digital data over a radio wave. OFDM works by splitting the radio signal into multiple smaller sub-signals that are then transmitted simultaneously at different frequencies to the receiver: multiple carrier waves take the place of and carry the data of one large wave. One of the key benefits of OFDM is that the multiple carrier waves overlap, which provides a very efficient use of the frequency bandwidth by packing more data into the bandwidth compared to what can be achieved with a single larger carrier wave spread across the same spectrum. Also, OFDM reduces the amount of crosstalk in signal transmissions. Among others, the IEEE 802.11a and 802.11g Wi-Fi standards also use OFDM as well as IEEE 802.16.

- B. ITT Mesh** connecting the boarding party onboard the RHIB during their transition to Target Vessel and on board the Target Vessel providing wireless mesh capability to the boarding party members.

Not much data exists on the aforementioned wireless mesh technology that uses a center frequency of 900 MHz since it's a proprietary technology of ITT (owned by Motorola).

- C. 802.20 FLASH OFDM** (Fast, Low-Latency Access with Seamless Handoff Orthogonal Frequency Division Multiplexing)

Introduced by Flarion Technologies, Inc. (owned by QUALCOMM Incorporated) FLASH-OFDM utilized in the 802.20 standard is a direct competitor to the yet to arrive 802.16e mobile broadband standard. IEEE 802.20 standard is capable of providing connectivity to the BS of SS moving up to speeds of 200-300 knots. FLASH-OFDM differs from 802.16 OFDM applications, in that it is vertically layered across the network, link and physical layers of the OSI model. This implementation is possible because in an IP network, only the layers above the network layer need to be layered horizontally to ensure interoperability across multiple link layer technologies. The 802.16 standard utilizes multiple MACs for multiple Physical layers and has run into design challenges because of the large amount of internetworking needed between the 802.16 MAC and PHY layers. 802.20 on the other hand utilizes a non-contention MAC together with OFDM which allows for the support of many low bit rate dedicated control channels. Therefore, IEEE 802.20 standard isn't subject to various performance variations and inefficiencies when dealing with mobile users like IEEE 802.16 because it provides a fully scheduled uplink and downlink air resource to the user while IEEE 802.16 MAC is provided primarily through a contention-based access scheme.

During the TNT 06-02 experiment the utilized frequency was approximately 700 MHz and the EIRP was 20 W. The 802.20 frame is 26 bytes, of which 2 bytes form the frame header.

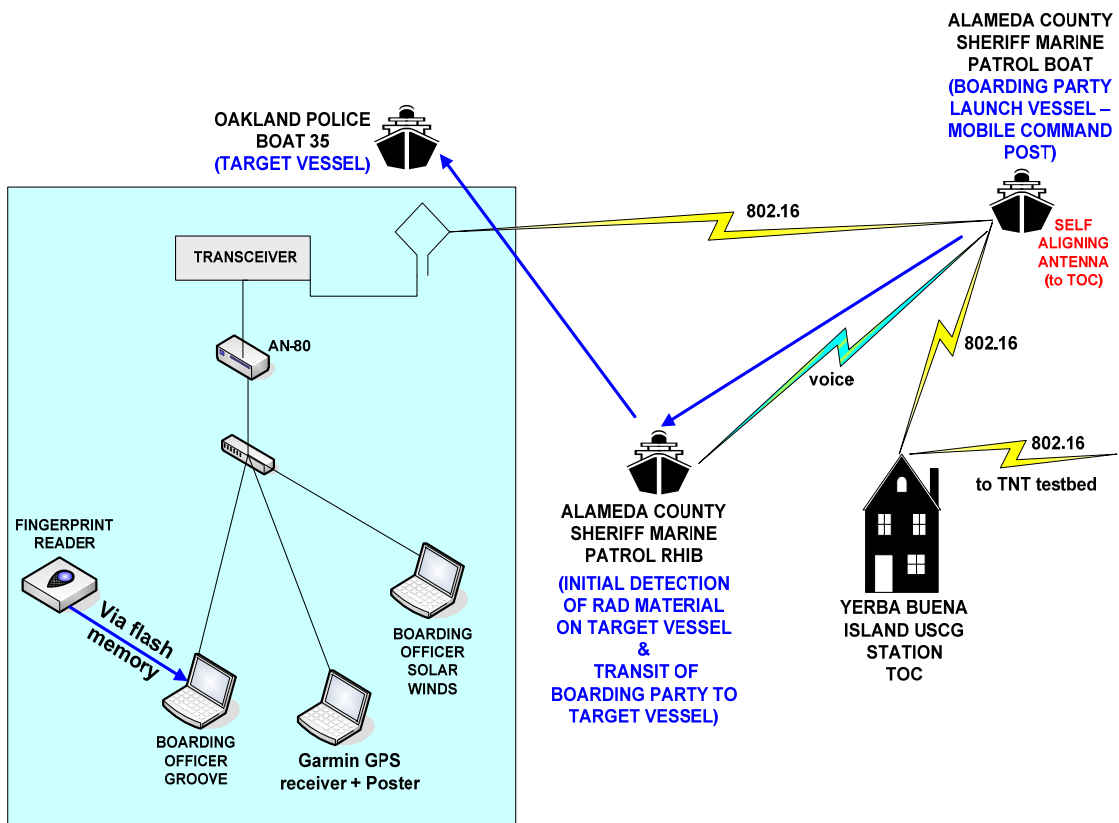
- D. UWB** portable data communications equipment.

UWB has its origins in military secure communications. While in Spread Spectrum (DSSS / FHSS) the bandwidth is in the range of MHz, in UWB it's in the range of GHz. Instead of modulating a continuous wave form RF signal with a specific carrier frequency (narrowband communication systems), UWB use carrierless, short duration pulses with very low duty cycle ( $T_{on}/(T_{on}+T_{off}) < 0.5\%$ ) that spread their energy across a wide range of frequencies (while in SS carrier is always present).

Therefore, mainly because of the obstacle penetrating capabilities as well as the extremely high throughput over short distances (as said, UWB might replace USB 2 and IEEE 1394 wired connections between peripherals) providing the ability of excellent streaming video quality, UWB is ideal for use inside a ship's hull.

#### 4. Collaborative Network for Maritime Radiation Awareness and Interdiction Experiments

The diagrams in Figure 3 and Figure 4 below show the MIO Logical Network set up in San Francisco Bay, which Stiletto joined as a mobile command post pier sided in San Diego (Fig. 3). Each of these nodes had a specific role in the scenario and participated differently in the collaborative environment. Their roles are described following the diagrams.



**Figure 3. TNT 06-4 MIO Network in SF Bay Area**



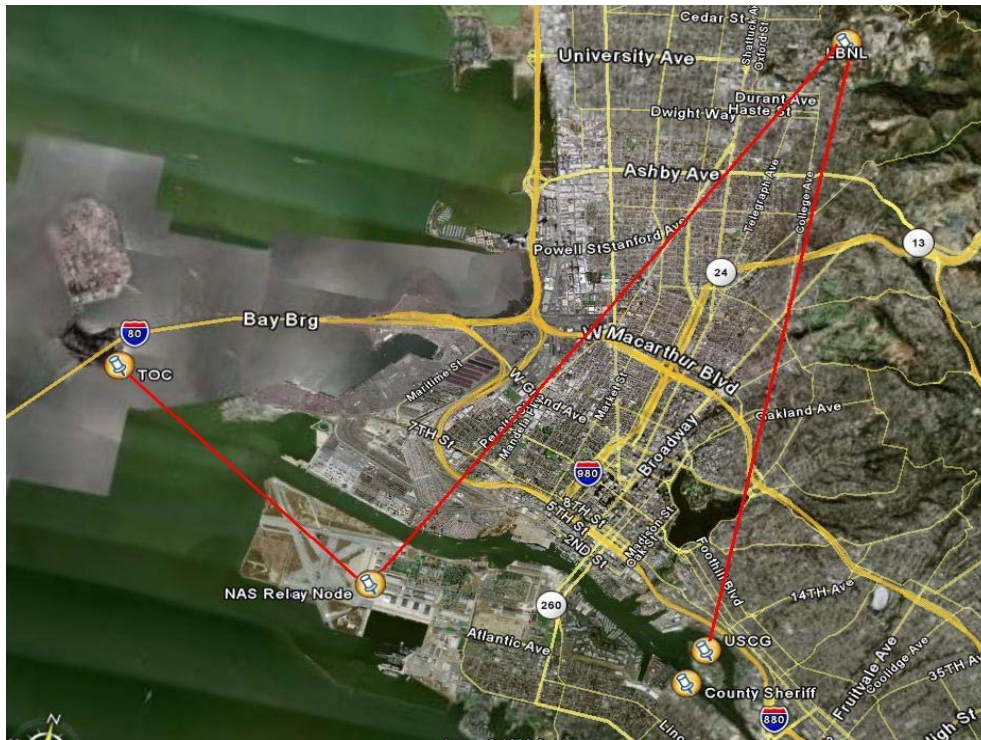


Figure 4a. OFDM Wireless Network in SF Bay Area

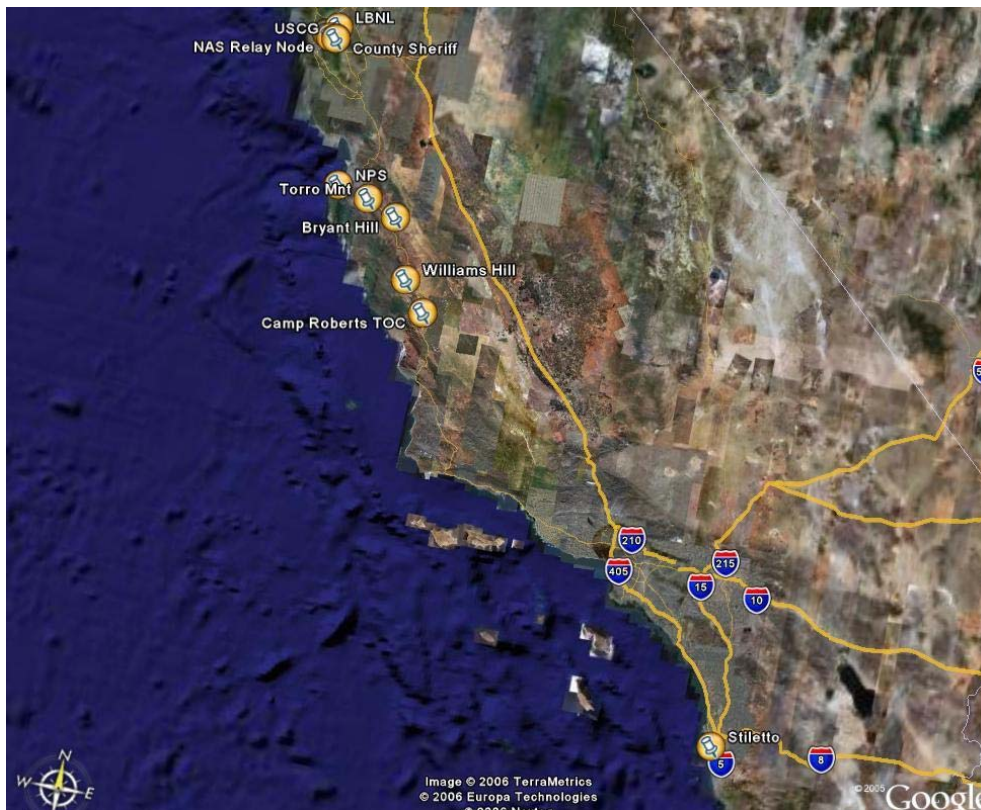


Figure 4b. OFDM Nodes along coastline from SF Bay to Camp Roberts



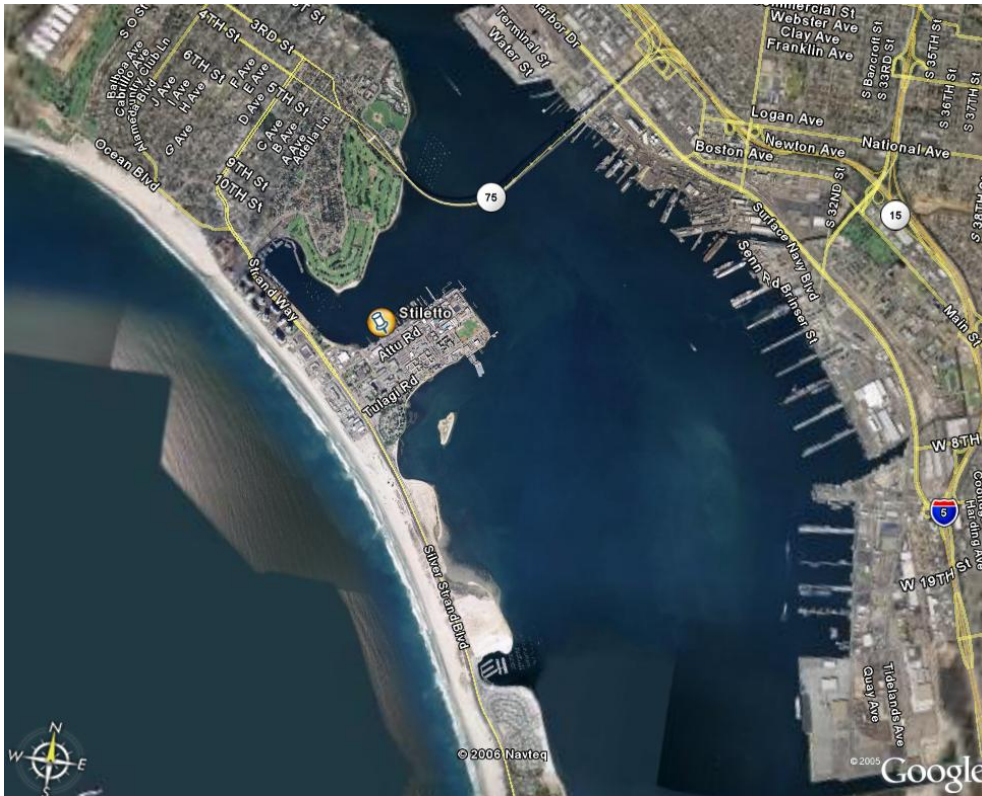


Figure 5. OFDM Wireless connection to Stiletto in San Diego

## 5. MAJOR EXPERIMENT PLAYERS AND ROLES

### Networking / Technical Advisors (NOC (NPS) & TOC)

Role: to provide their expertise to the Boarding Party (BP) to deal with complex networking problems that might arise at any point of the boarding operation that would obstruct them from exploiting the unique capabilities offered by the network.

### Lawrence Livermore National Laboratory (LLNL)

Role: to provide Weapons of Mass Destruction (WMD) expertise and specifically radiological material detection, identification, categorization, origin tracing, their correlation with other related findings worldwide, and evaluation of their associated dangers and implications from their discovery. That expertise also includes the identification of certain materials that can lead to the development of WMD, such as machinery and other non-proliferation materials.

### MIFC (Maritime Intelligence Fusion Center)

Role: to provide maritime traffic information such as ships' registries, cargo and crew manifests, ports of call, and shipping schedules. This information is helpful in order to

designate a vessel as suspect, locate it, make its interdiction possible, and confirm discrepancies onboard, such as fake documentation.

### **Command Center (NPS) & District 11 (tactical / operational commanders)**

Role: Primary decision makers concerned with decisions before, during, and after the boarding, with particular emphasis on post-sensor analysis of the suspect vessel. The boarding officer is their “tool” onboard the ship, making decisions at the lowest level, following pre-established SOP’s including how to organize and conduct the search using the best resources at his/her disposal. The decision making level of the tactical or operational commanders may differ depending on the context of each boarding case, their parental organizations, relevant policies and standing orders. The primary purpose of the collaborative network is to enhance the Boarding Party’s situational awareness, even more importantly that of the boarding officer.

### **Boarding Party**

Role: to physically enter the vessel and carry out a thorough visual and sensor inspection to locate the source of radiation detected by the drive-by sensor. The BP will then pass sensor data to LLNL for analysis and evaluation of the type and severity of the source.

### **Stiletto 1**

Role: to act (experimentally) as a MIO unit, capable of fast transfer of the BP to the target, providing launch vessel and intermediate node capabilities.

### **Singapore (as Shipping Company)**

Role: to provide the above information to maritime intelligence / maritime domain law enforcement agencies such as MIFC (in this experiment, to explain the presence of specific materials and/or personnel onboard the suspect vessel).

### **Sweden**

Role: to act as a counterpart MIO agency, conducting the same operations and exchanging real time information that might be useful to them or to the TNT operation.

Based on the observations of the MIO team members after having the opportunity to both observe and actively portray the roles in each node, Figure 1 was re-created as Figure 4 (below) to reflect the team’s perception of the collaborative network that existed during the experiment. Note the high number of arrows between the Technical Reach-back nodes – those entities supporting the technical aspects of the experiment – and the Coast Guard nodes. The expertise housed in the Technical Reach-back nodes is a resource in high demand from multiple operational nodes, but is also an extremely

constrained resource. The ability to simultaneously “deploy” the technical expertise to multiple locations/events through the collaborative environment is an essential benefit for military and Homeland Security operations.

The one major deviation from the “real world” Coast Guard structure during this experiment environment is the role of the Yerba Buena Island node. In the actual Coast Guard chain of command, Sector San Francisco would replace the YBI TOC and would exercise some of the command and control (C2) role played by D11. In addition, the critical logistics role played by the YBI node for the experiment would not be necessary because the technology and network management issues would be addressed before this collaborative environment was fielded. During future experiments, it may be beneficial to gradually decrease the dependence on this node by slowly distributing its responsibilities to the District 11, Boarding Vessel (BV), Boarding Team (BT), and NOC nodes.

Student watchstanders at the NOC were prepared to serve as surrogate role players for the various foreign partner nodes, in addition to facilitating their connectivity and ensuring that they clearly understood their roles.

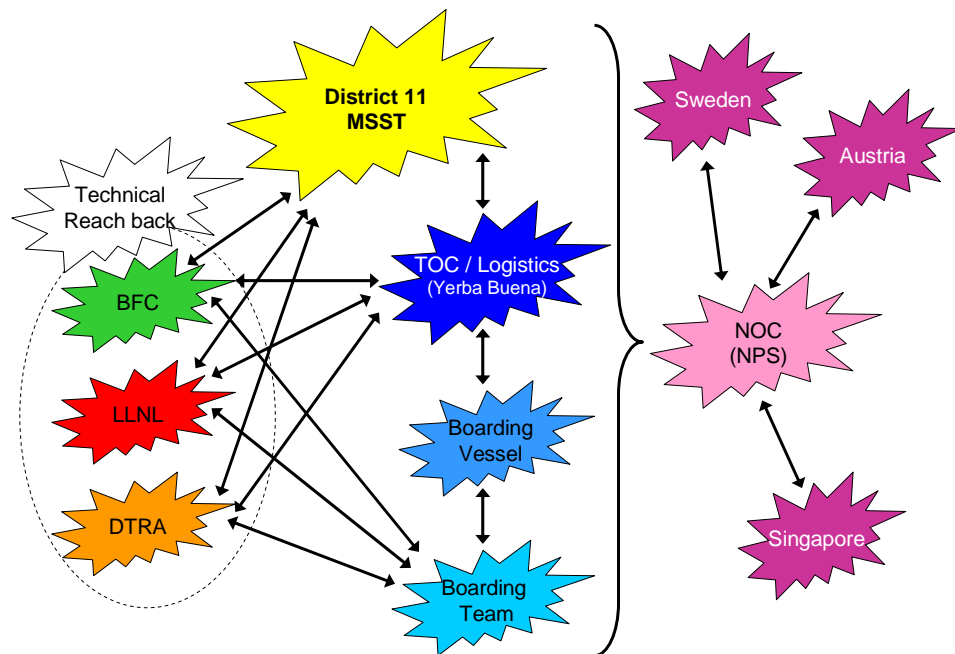


Figure 6. MIO TNT Collaborative Network Nodes (courtesy Rideout, Creigh, and Dash)

## 6. Application environment of MIO collaborative network nodes that Stiletto joined.

Groove Virtual Office provided the majority of the collaborative tools for this experiment. The following workspaces were created to perform the tasks listed below:

- 1) TOC and Networking

- To resolve network malfunctions/issues and optimize network performance
- To coordinate logistics and issues outside the scenario environment

## 2) Boarding Party (BP)

- To analyze and compare spectrum files (among remote experts)
- To track radiation materials (among remote experts)
- To share atmospheric modeling and predictions (among remote experts)
- To consider emergency medical actions (among remote experts)
- To post biometrics matches (NBFC)
- To post radiation files/photos (BP)
- To post responses/expert evaluations (LLNL)
- To post recommendations on BP's further actions / when additional search information is required (LLNL-NBFC)

## 3) District 11

- To command and control assets
- To direct agencies and assets not directly under the commander's authority
- To command BP to appropriate actions

Each of the collaborative network nodes utilized a subset of the available CT tools. The section below provides a breakdown of each node and a description of their collaborative environment.

### **District 11 – Rusty Dash.**

The combination of the tools listed below provided the ability to remotely monitor both the status of operational assets (boats/vessels) and the progress of scenario events. This resulted in excellent situational awareness for the decision maker.

Groove was used in the following ways or to perform the following functions:

- *Discussion Board / Chat* – for text communication between nodes. The discussion board is better than chat because it enforces hierarchy relationships of the different posts. This makes it much easier to follow information in the asynchronous and distributed decision making environment.
- *File Transfer* – primarily for distributing data files from the BT to/from the Reach-back facilities.
- *Task Manager* – using this tool in the control (TOC and Networking) workspace gave participants an easy and informative way to monitor the progress of the scenario. It was an excellent use of a previously unused Groove tool.

SA Agent provides the geographic positions of the assets and status of the network links for the mobile nodes.

EWall was used to monitor information alerts. However, the sparse number of alerts posted in EWall limited the effectiveness of the tool during this experiment.

VOIP phone was an excellent tool for voice communications. Video streams were monitored from various nodes, but this functionality was not critical to the D11 decision making process.

### **Boarding Officer – Brian Rideout and George Stavroulakis.**

Of the various features (often referred to as “tools” within various collaborative applications) there are 3 fundamentals in the Groove application that apply specifically to the MIO scenario. They are:

- 1) Discussion. Utilize standardized naming conventions and SOPs for introducing new threads. Employ the thread technique to better organize data (decreases look-up time of information thereby speeding up the Orient/Decide processes within the OODA loop). It provides excellent, near-real-time “chat” capability while archiving all discussions for all parties. Additionally, person-to-person discussions can be established and continued to cover communications not pertinent/appropriate for the entire workspace.
- 2) Task-Manager. Create a flexible, scalable MIO model that can rapidly expand to cover all aspects of the various boarding missions: one for a radiation scenario, counter-drug, weapons, suspected terrorist(s), etc. With an adaptable template, users will become familiar with those components most frequently used while retaining the option of expanding the task-manager’s options depending on the situation. Familiarity breeds confidence and increases our orientation/decision cycle in the OODA loop.
- 3) Files. This tool is used primarily to transfer data (photos, video, biometrics, radiation data, etc) to be collaborated on by reach back analytical agencies. Features like pictures, notepad, and sketch (in Groove) are redundant and bog down users. Workspaces can be configured to reflect only those features the users intend to use thereby minimizing the temptation to open another feature. Additionally, fewer features in the workspace will force users to use only those available with the option of expanding the workspace through the additional of more tools; less features equals less to review equals less time spent with a head buried in the computer.

On another note, a camera acts more like a sensor and less like a collaborative “tool.” The data it captures can be collaborated on (by humans) once it has been disseminated via the network (Groove has capability of posting/sharing the file but the humans using Groove then collaborate on the data presented in the file). Whether still imagery or streaming video, we tend to categorize cameras in the collaboration realm rather than “sensor” domain.

Additionally, the laptop that was supposed to be used for Situational Awareness Agent (SA Agent) aboard the BV was not brought along for the boarding. The lack of Alerts, Geospatial data, Network connection (Agent information) and video had a noticeable impact on the BT’s situation awareness. SA Agent’s capabilities would be especially beneficial in a complex MIO with multiple surface craft on the water.

Having that kind of SA (especially at night) would be beneficial to law enforcement and collaborators alike.

### **Boarding Vessel – Bob Creigh.**

The BV primary CT Tools were Groove and the VOIP phone. The BV was a coordination entity that provided a bond between the TOC, D11 and the BT. The BV also provided the physical network link between the TV and YBI 802.16 node. The BV also provided a video feed. This camera was placed on the bridge of the BV but in a real situation would probably stay locked on the TV. The BV did not make use of the SA Agent during this experiment but it should be used in the future.

Groove proved to be a very valuable tool for the BV team. The first day of the experiment the network latency was unacceptable and we primarily used cell phones for communications. On the second day these problems were rectified and both Groove and the VOIP phone proved exceptionally valuable. The VOIP phone is an outstanding tool and should be used even more widely in future experiments.

### **Stiletto Ship (specific type of BV) – Jeff Withee.**

Groove provided the majority of the CT tools. It was utilized for Chat, discussion, File Sharing, pictures, and task management. Video and Voice communications were provided by VStream. Additional voice communications were conducted using Cell phones.

### **CENETIX NOC – Dave Schilling, RJ Simmons, Ed Pena, Doris Alvarez, Ed Macalanda, Mike Farrell.**

The NOC utilized all of the available collaborative tools for the experiment: Groove, E-Wall, SA Agent, Video Conferencing, and Audio Conferencing. Groove was used for file sharing, messaging, chat, discussion board, pictures, and web links. This constituted approximately 80% of the CT utilization. EWall was used about 10% and teleconference another 10% mainly for coordination during the initial experiment setup.

The Austrian team utilized Groove, E-Wall, SA Agent, a live Video link, and occasional Cell Phone communication.

Sweden participated in the SA agent as number 26.

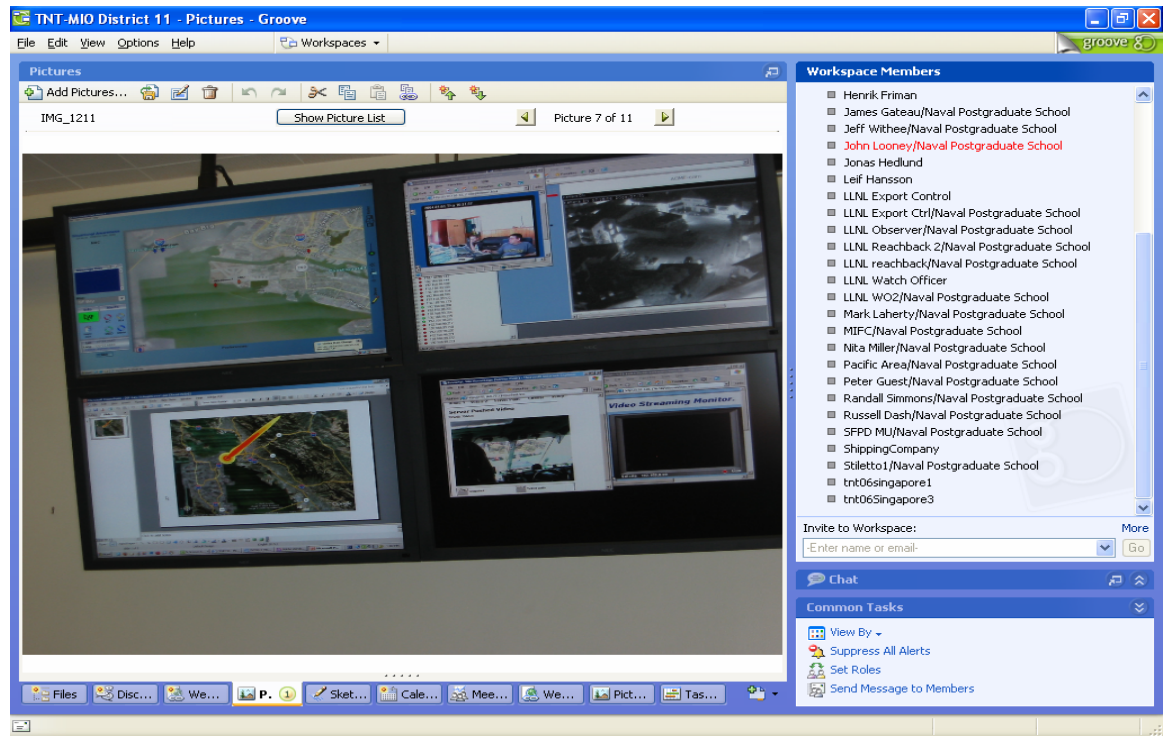


Figure 7. Collaboration with remote sites involved in drive-by radiation detection

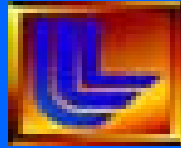
## 7Conclusion

The last experiment proved feasibility of integrating new Radiation Detection sensors in the improved tactical MIO network and provided vital requirements for configuring networking and operations support capabilities onboard Boarding Vessel and remote Expert and Command Centers. The ship-to-ship and ship-to-shore OFDM wireless network between Boarding Vessel and MIO TOC allowed the Boarding Party team in SF Bay to communicate with the geographically distributed network of MIO command posts. Also, the NPS CENETIX-developed first self-aligning broadband wireless solution (SAOFDM), was successfully tested at SF Bay on board the Alameda County Sheriff's boat, in a configuration similar to Stiletto. The MIO network provided sufficient bandwidth for collaborative tools and multiple video feeds (1.5-3Mbps level), even when subjected to additional sharp zigzag movement of the vessel, to as far as 4.5 miles off shore. In addition, the members of the Stiletto TOC were able to communicate and observe video/radiation detection from the remote warning sites in Sweden, Austria, and Singapore.

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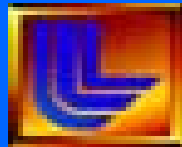
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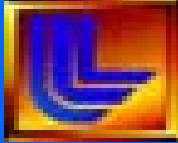
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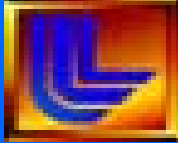


# Objectives

- Evaluate the use of networks, advanced sensors, and collaborative technology for rapid Maritime Interdiction Operations (MIO); specifically, the ability for a Boarding Party to rapidly set-up ship-to-ship communications that permit them to search for radiation and explosive sources while maintaining network connectivity with C2 organizations, and collaborating with remotely located sensor experts.
- Extend the set of participating organizations to coalition partners (currently includes international teams in Sweden, Singapore and Austria) and first responders (currently includes San Francisco, Oakland Police, and Alameda County Marine Units)
- Provide the recommendations for transforming advanced networking and collaborative technology capabilities into new operational procedures for emerging network-centric MIOs



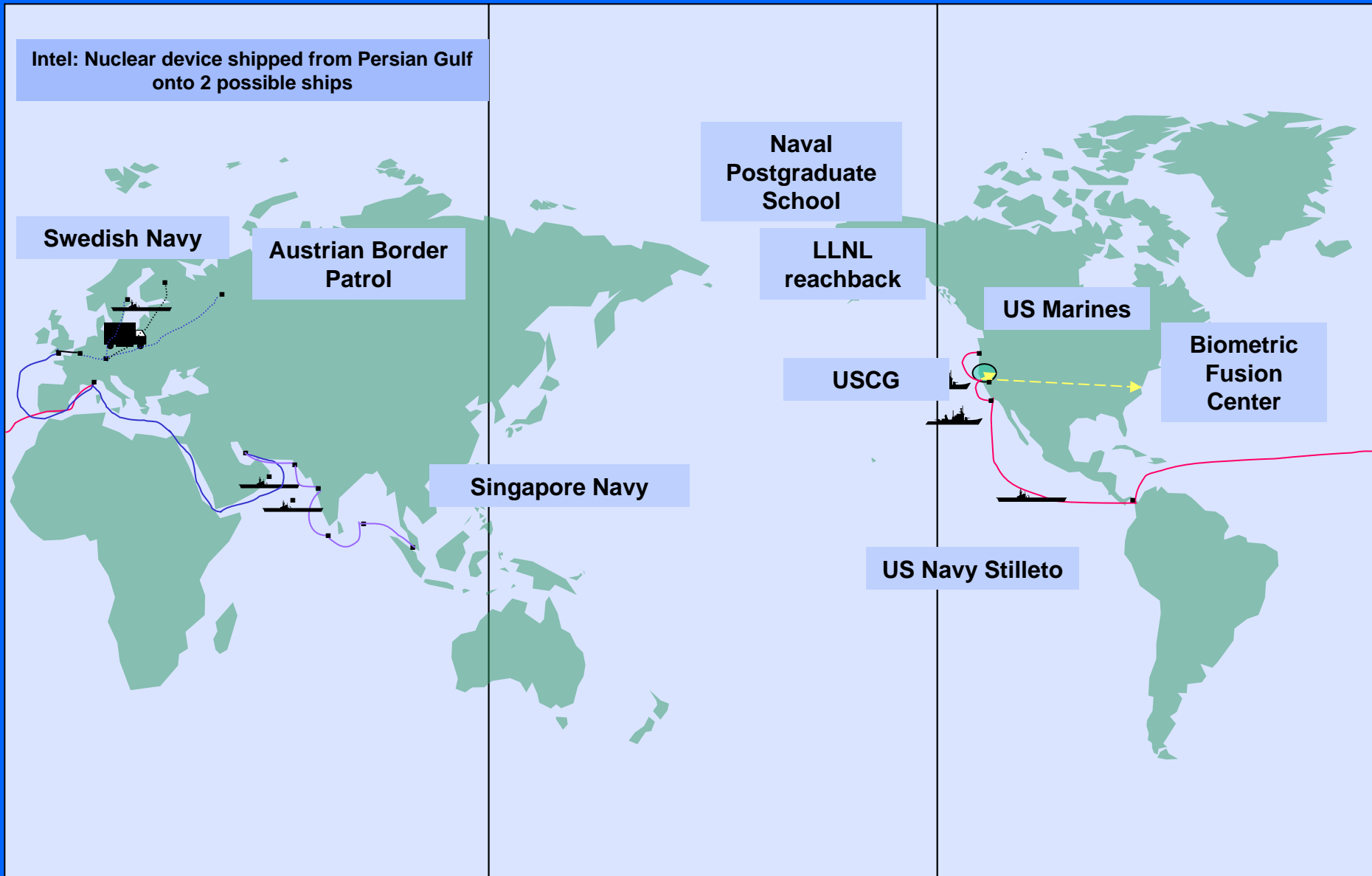
# TNT MIO Testbed: System of Networks and Collaborative Technology for Supporting Globally Distributed MIOs



# Plug-and-Play Sensor-Unmanned Vehicle-Decision Maker Networking Testbed with Global Reachback

- Plug-and-play wide area adaptive network with global reach back capabilities and rapidly deployable self-forming wireless clusters (including student network operation services 24/7)
- Local networking clusters: ship-to-shore, ship-to-ship, ship-UAV-ship, ship-USV-ship, ship-AUV, sensor mesh mobile networks
- Operational focus: Boarding Parties support, MIO connectivity and collaboration for radiation awareness, biometrics identification, non-proliferation machinery parts search, and explosive materials detection on the board of the target vessel during the boarding party search phase
- Testbed backbone: NPS (Monterey), USCG (Coast Guard and Yerba Buena Island in SF Bay Area, Camp Roberts (Central California),
  - New sites: Golden Gate Bridge, Mt. Diablo, Sacramento River delta
- Global VPN reach back :
  - East Coast (BFC, DTRA)
  - Sweden (Navy site in Southern Sweden),
  - Austria (GATE site in Bavarian Alps-Salzburg Research)
  - Singapore (DSTA), and

# Example Scenario and Global Partners





# NPS-LLNL MIO Cooperation Partners

## NPS Team

**Networks:** ship-to-ship, ship-to-shore  
**Collaborative Technology**  
**Operations & Command Center**  
**VPN reachback**  
**Unmanned vehicles**  
**Biometrics**

## LLNL Team

**HOPS**  
**Export Control**  
**Radiation Reachback**  
**Plume Modeling**  
**Radiation Sources**  
**Radiation Detection**  
**Ultra-wide band Communication**  
**Explosives Detection**

## Participating DoD and U.S. Gov't.:

- USSOCOM
- OSD/HD
- Biometric Fusion Center
- NIST
- MARAD
- USCG/D-11
- US Marine Corps
- DOE Radiological Assistance Program
- OFT
- DTRA

## Foreign Partners:

**National University of Singapore/DSTA**  
**Swedish National Defense College/Swedish Naval Warfare Center**  
**Salzburg Research**  
**University of Bundeswehr at Munich**

## State and Local Government

**Alameda County Sheriff**  
**Oakland Police Dept.**  
**San Francisco Police Dept.**  
**California Office of Emergency Services**



## Field Experimentation Cooperative Tactical Network Topology Testbed

NPS CIRPAS UAVs  
and Manned Aircraft



Local Access Ft.  
Ord MOUT



MIO Extension

U.S. Army  
SATCOMSTA



MOA with Ft.  
Hunter Liggett,  
USAR (1-07)



MOA with  
Camp Roberts  
ANG



802.16

~100 mi

VPN/GIG



NPS CENETIX

NPS Beach  
Lab



ITT Mesh

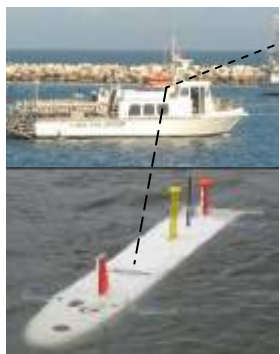
NPS  
Experimentation  
East  
Dahlgren/Norfolk  
2-07

NPS/CIRPAS McMillan  
Field UAV Flight Facility

Unlimited Use of Restricted  
Air Space



Monterey Bay,  
Pacific Ocean

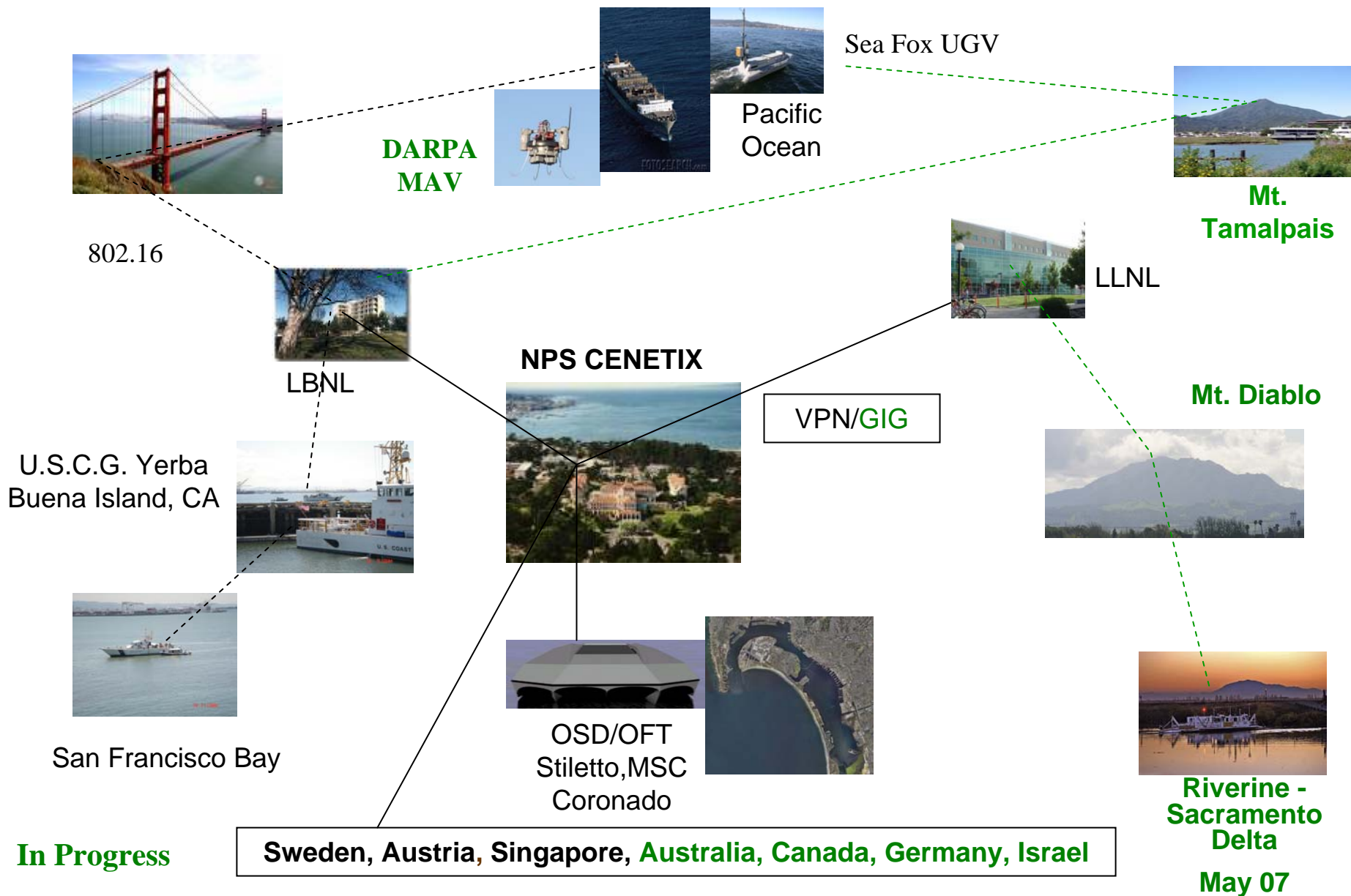


In Progress

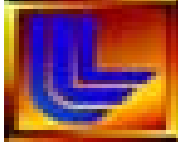




# TNT MIO Testbed: Self-Forming Broad Band Wireless Backbone

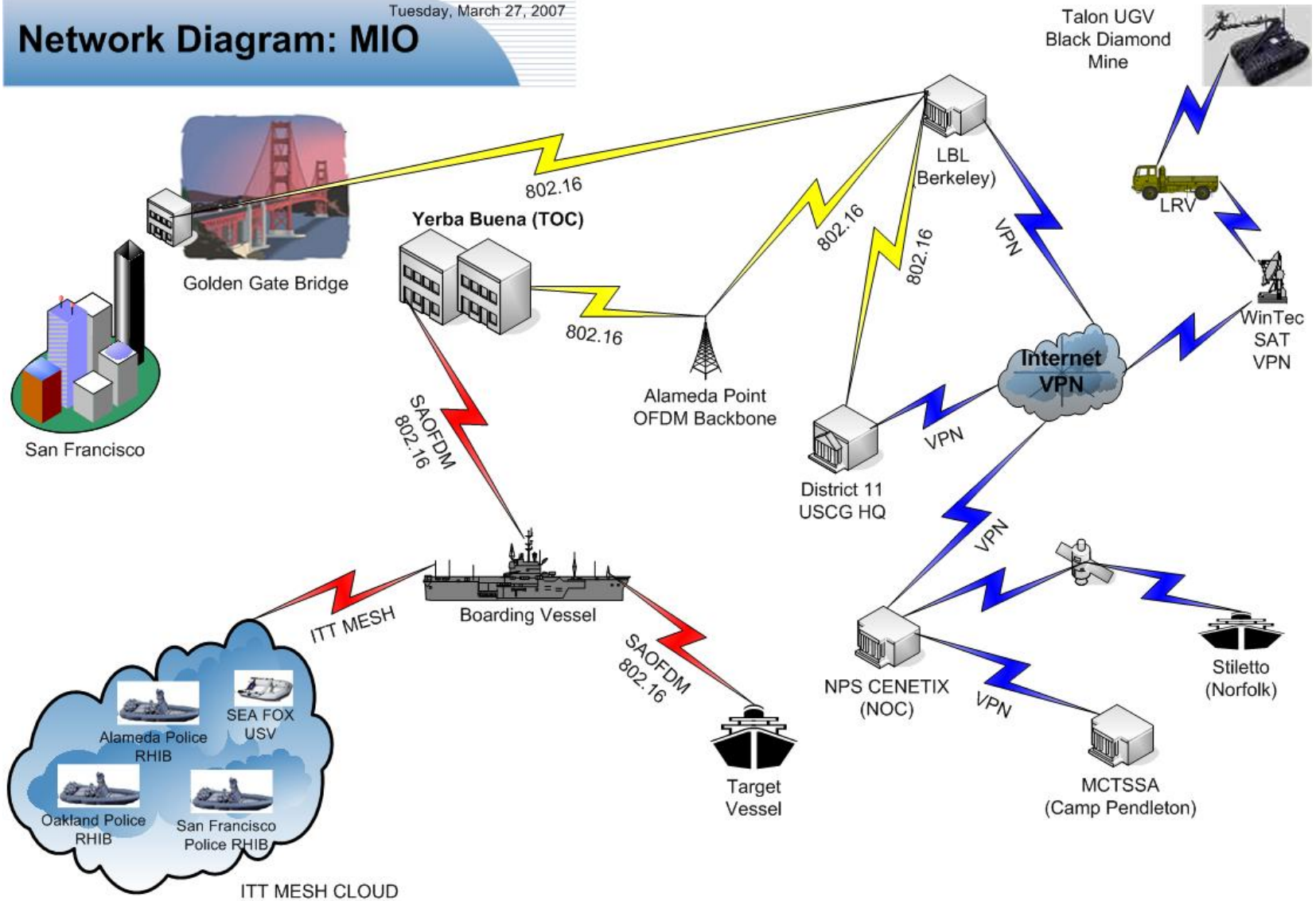






Tuesday, March 27, 2007

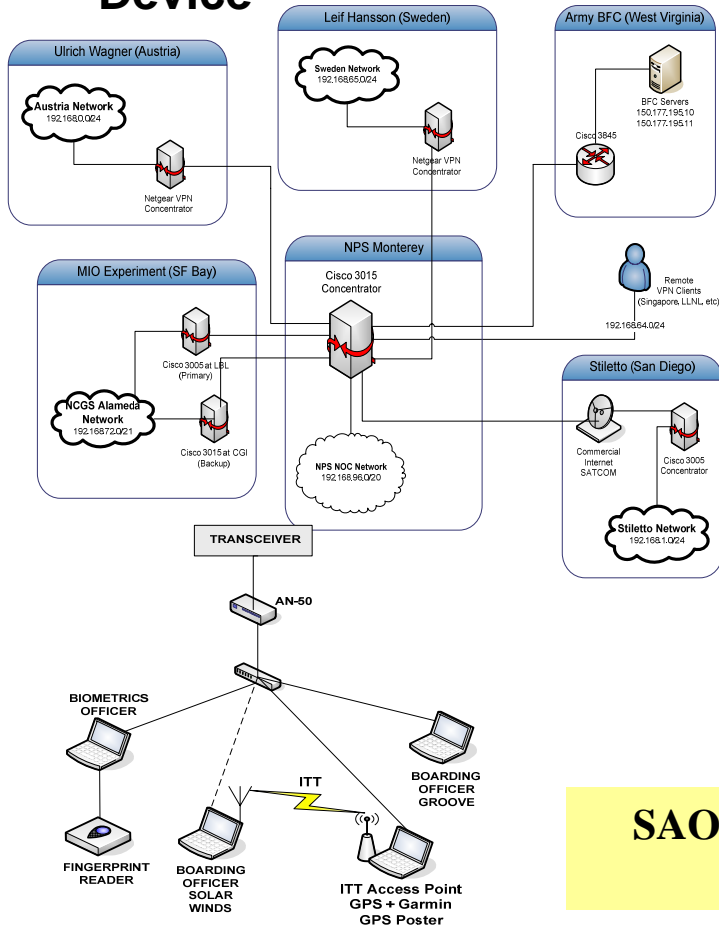
## Network Diagram: MIO



# Networking Solutions for Rapid Radiations Detection and Biometrics Identification

## VPN Reachback and Mesh Networking with Biometrics

### Device



## Broadband Ship-to-Shore/Ship-to-Ship Adaptive Networking : SAOFDM Solution



**SAOFDM Network operated completely of the SA screens w/o experts support on board vessels**

## TNT 07-2



Data input at TOC



Examples of Fast ID on water



Day 1: Data captured on target vessel



Day 2: Day 2 ID

Total response time from beginning to enter thumb prints  
on suspect to receipt of ID:

~5 sec if “bad guy”

~35 sec if “other”

At Camp Roberts Checkpoint:

Without ABIS, Local FAST ID 1-2.5 min

With ABIS and Full Encounter, TOC Data Base 2-4 min



# Background MIO Studies: Rapidly Deployable Self-Forming Network for Maritime Interdiction Operations



## Field Experimentation Program (Dr. Dave Netzer in Lead )

### Large Interdisciplinary NPS Team

**NPS: - FY06:**                28 Thesis Students  
                                      32 Faculty  
  
                 Includes 21 PhD, 4 PhD Students  
  
                 - Course Projects: IS, OR, DA  
  
10 Departments and Institutes

### Affiliated Programs

**DARPA HURT ACTD**  
**DARPA MAV ACTD**  
**USSOCOM Global Reach ACTD**  
**AFRL JASMAD**  
**MCWL Distributed Operations**  
**OSD/OFT Stiletto**  
**OSD/HD MDA**

### Participating Universities

**Virginia Tech**  
**University of Florida**  
**Case**  
**MIIS**

### Broad DoD and Gov't. Participation and Support

**- USSOCOM**  
**- USASOC**  
**- AFSOC**  
**- NAVSPECWARCOM**  
**- JSOC**

### Participating DoD and U.S. Gov't.:

AFRL	BFC
DARPA	DTRA
LLNL	MARAD
NSA NTIO	NRL
ONR	ONR 113
SPAWAR	USCG
USN/VC-6	OSD/OFT
NASA/ARC	STL
USASMDC	JHU APL

### Industrial Support

**WinTec**  
**Inter-4**  
**Redline Communications**  
Flarion  
Northrop Grumman  
Lockheed Martin  
ITT  
AeroVironments  
Space Data Corporation  
Brandes Associates, Inc  
Chang Industries  
L-3 Communications  
AGI  
Mitre  
Mission Technologies

### State and Local Government

Alameda County Sheriff  
Oakland Police Dept.  
San Francisco Police Dept.





# Field Experimentation Research Areas



## CENETIX

**OSD/OFT  
WolfPAC – Stiletto  
Experiments**

**OSD/OFT  
HA/DR Project**

**NJ Health  
Emergency Medical  
Response Network**

**OSD/HD  
NPS Maritime Security  
Program**

**USMC Field Experiments**

## SOCOM - NPS Field Experimentation Cooperative

- Agile, Adaptive Tactical Networks with Long-Haul Reach-back; Ground, Airborne, Ship, Underwater
- Collaboration Technologies
- Integration with GIG-EF via DREN (CONUS), GIG-BE (theater locations, satellite links), and Abilene (Internet 2 backbone) (overseas clusters)
- Shared Situational Awareness
- Unmanned/Autonomous Vehicles
- Network Controlled UASs
- Networked Sensors
- Dual-use Technologies for Post-Conflict Reconstruction, Stabilization, HA/DR

## Sites:

- **Camp Roberts**
- **Ft. Hunter Liggett**
- **Monterey Bay**
- **San Francisco Bay**
- **Avon Park, FL**
- **etc**

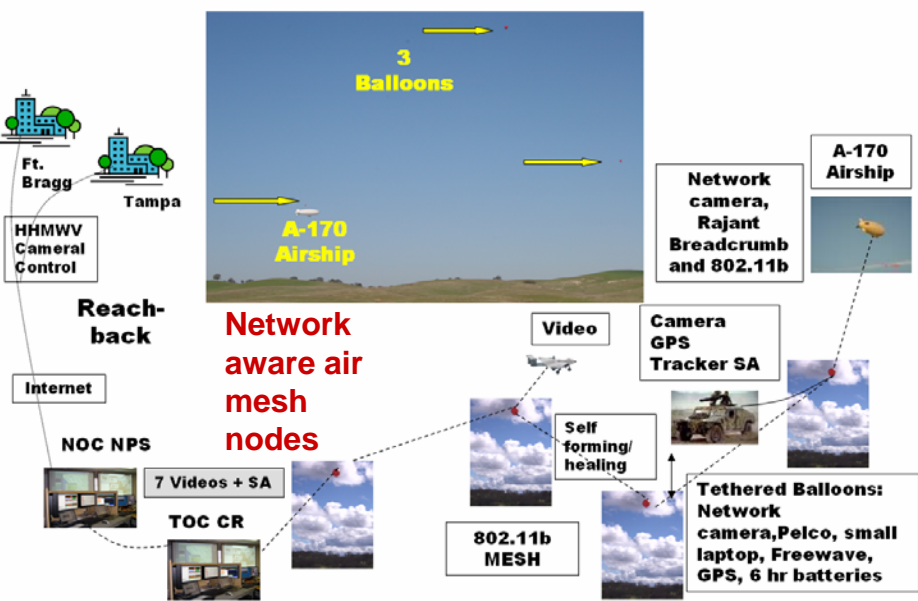
- IED Detection and Jamming
- Smart Antennae
- Precision Tracking and Targeting
- Network Vulnerability Assessment
- Red Team Intent
- Human Systems Integration (Warfighters as Users and Evaluators)
- CONOPS
- Individual Identity Friend or Foe
- NGO-Warfighter Combined Operations

- Modeling and Simulation
- Biometrics
- Airspace Management/Deconfliction
- Data analysis and mining
- Image Enhancement, Mosaics, Stitching



# TNT 05-1, Nov 2004

## MESH Topology



# TNT 05-2 Feb 05

## Improved Camp Roberts TOC



## VC-6 with TERN UAVs



## Cypress Sea Approaching USCGC HAWKSBILL - Radiation Detection



## Surrogate Light Reconnaissance Vehicle



## TERN Network Payload

## Balloon Payload



# NA Sea Nodes TNT 05-2 Feb 05

## Cypress Sea Support Boat



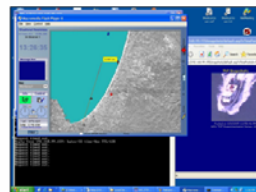
## Resolution Target for EO Performance Prediction



## Cypress Sea NOC



## SA for Cypress Sea, Pelican, Pelican Video



## NAVBOARD



## Pelican 802.16/ OFDM Payload



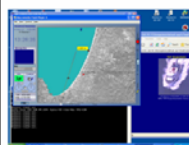
## ARIES AUV



# TNT 05-2 Feb 05

## Above and Below Water Situational Awareness for Combat Diver

## NPS NOC



## 802.16/OFDM VoIP

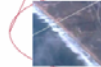
## Surrogate UAV



## GPS

## NA enables seamless SA

## Shore Image



## 802.11b or Mesh

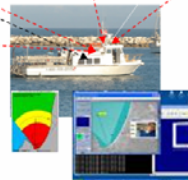
## ARIES AUV



## Mine Location and Image



## Cypress Sea with SA



## NAVBOARD





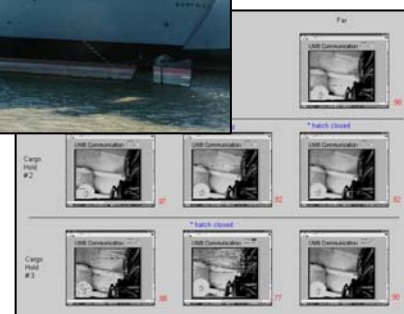
# Background: Prior NPS-LLNL experiments focused sending data and video in real time within a boarded ship to external networks



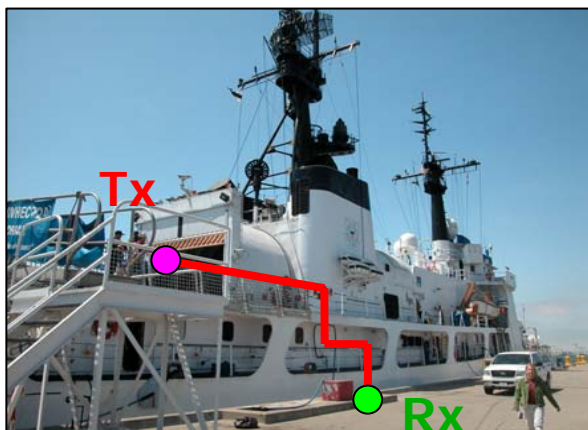
**Feb 05 TNT: 802.11B affected by radar**



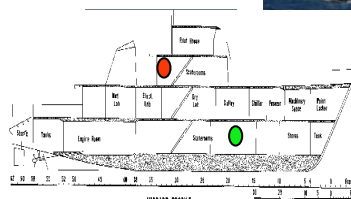
**May, August 05 TNT UWB comms demonstrated within Cutter**



**Suisun Bay: UWB able to transmit between holds of a container ship with holds closed!**



**UWB on board USCGC Munro (multi-deck, no radar)**



**Collected system performance data on operational ship (Point Sur) UWB WORKED in difficult high multipath environment**



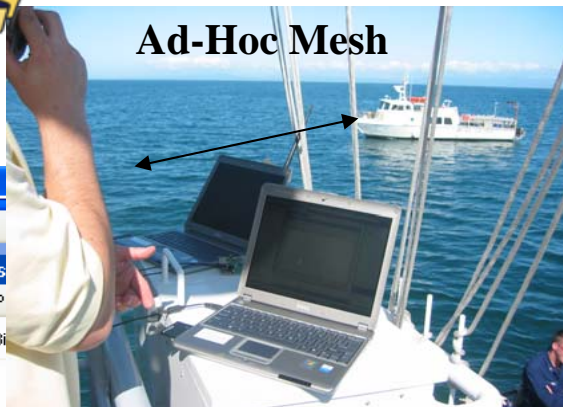
**Polar Star – Planned experiment w/ USCG R&D Center**



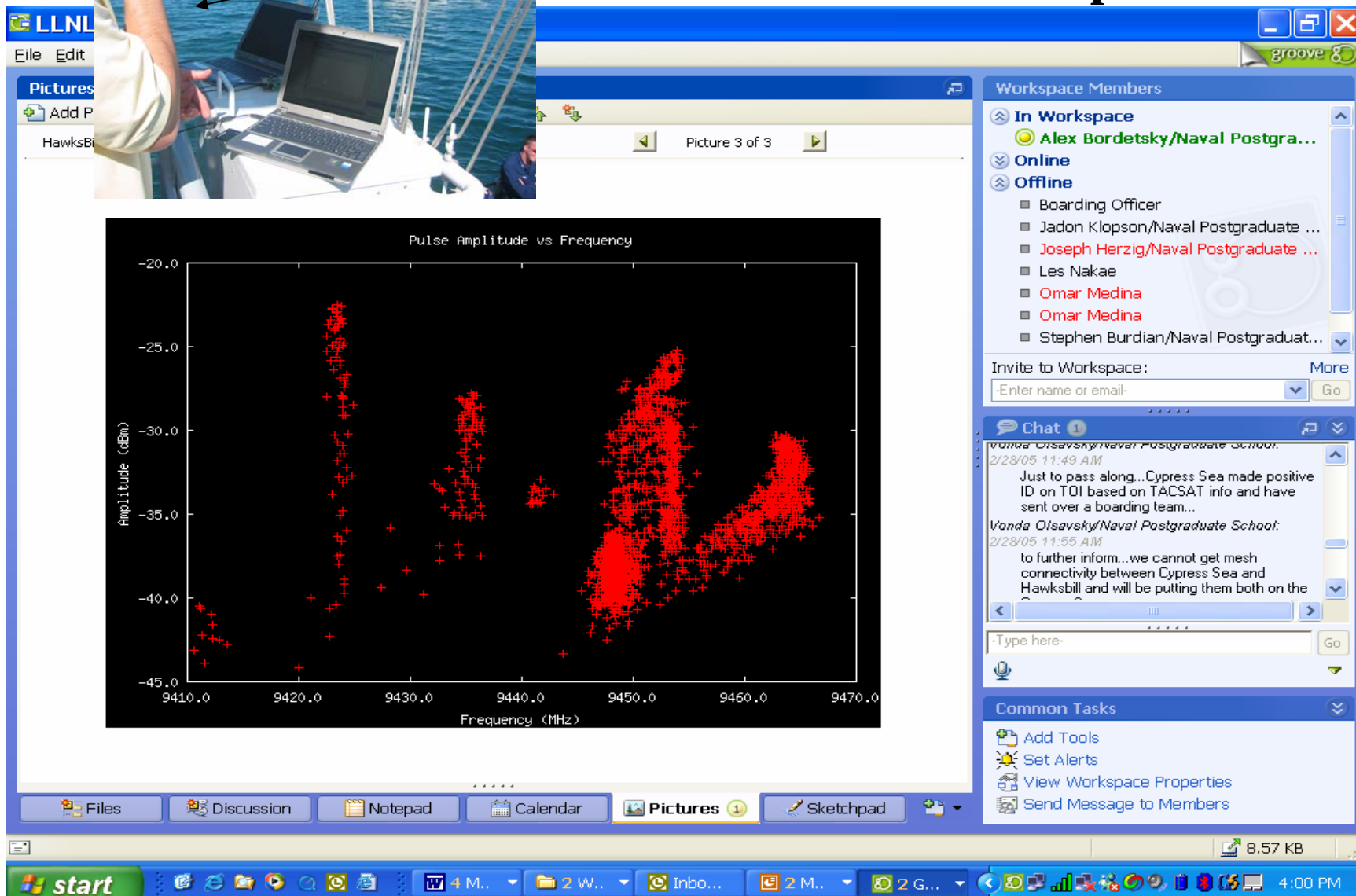
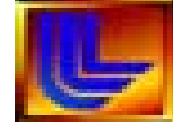


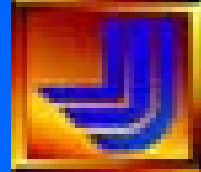
## Ship-to-Ship

Ad-Hoc Mesh



# Target Ship Enters Monterey Bay; Collaboration with TACSAT for Ship ID





# MIO Networking Accomplishments

# TNT 06-1 MIO Network Topology: Forming the Boarding Party network to the target ship





# Stretching OFDM Man-Pack Boarding Party Network to Target Ship (15min)



# Sending Target Crew Biometrics via Boarding Party Wireless Mesh network to the BFC (4 min)





# Stretching the UWB link below the deck to the Radiation Detection officers





# Sharing UWB Video with DTRA via Groove



**TNT 06-1 - Pictures - Groove**

File Edit View Options Help Workspaces

**Pictures**

Add Pictures... Show Picture List Picture 1 of 10

LLNL\_uwb\_video

## UWB Live Video

**Workspace Members**

- In Workspace**
  - Alex Bordetsky/Naval Postgraduate School
- Online**
- Offline**
  - Alan Viars
  - Arden Dougan
  - Boarding Officer Alameda/Naval Postgraduate School
  - Christine Paulson (LLNL UWB)
  - DoD BFC node/Naval Postgraduate School
  - DTRA/Naval Postgraduate School
  - Henrik Friman

Invite to Workspace:  More

Enter name or email:  Go

**Chat**

Christine Paulson (LLNL UWB): 11/22/05 12:13 PM  
BO: response to the radiation detection analysts: if there is Cs137 in the identifier, do we need to take a longer count to determine the source?

Boarding Officer Alameda/Naval Postgraduate School: 11/22/05 12:15 PM  
rg: ALL Arden response is in the Discussion

DTRA/Naval Postgraduate School: 11/22/05 12:16 PM  
Christine, DTRA still cannot read Station #2 File, but per BO comment above, file is specifically for LLNL

John Looney/Naval Postgraduate School: 11/22/05 12:17 PM  
do you need me to pass info to i. like via phone

Type here:  Go

**Common Tasks**

- Turn Off Tool's Unread Alerts
- Add Tools
- View Workspace Properties
- Invite My Other Computers

Files Discussion **Pictures** Text Web Links

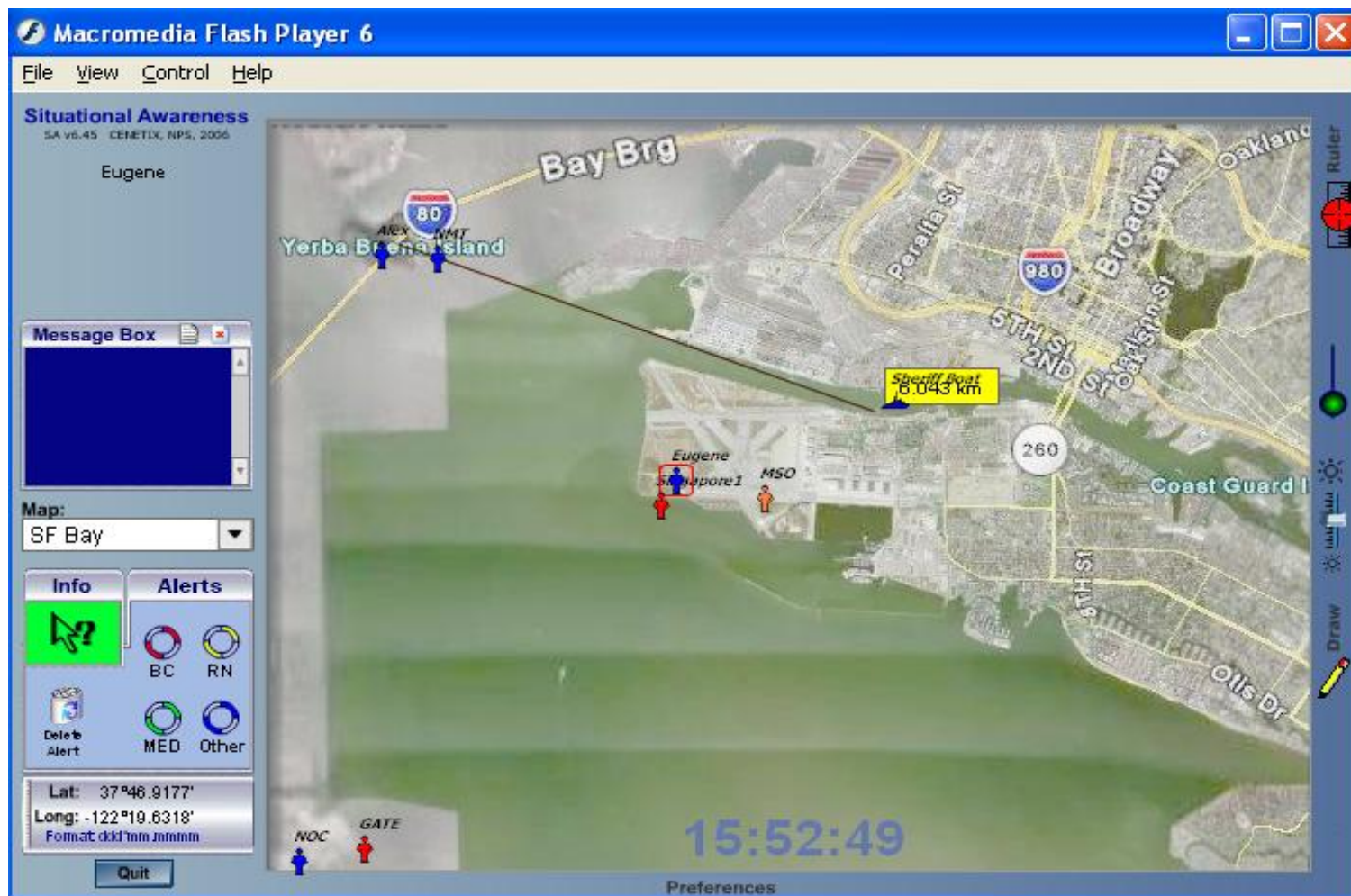
start 12:55 AM

# MIO Adaptive Ship-to-Ship and Ship-to-Shore Networking On-the-Move: First SAOFDM node





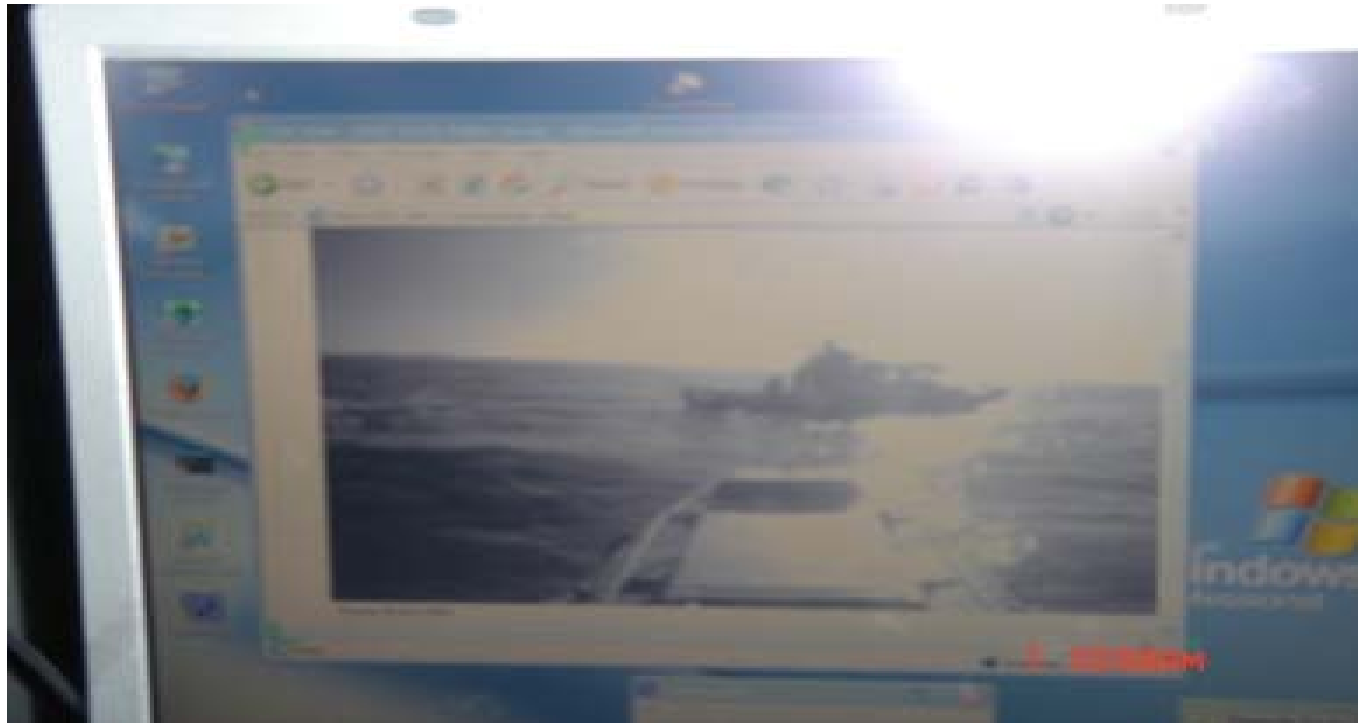
# Adaptive Ship-to-Shore link with Boarding Vessel operational behind port structures in the Oakland Channel



# Adding Unmanned Systems to MIO Network: Drive-by Search by Sea Fox USV



# Video Feed on the Target Vessel Provided by Unmanned Surface Vessel





# Adding Unmanned Systems to MIO Network: Drive-by Search by USV, UAV Relay to the Fast Boat, UGV in the Tunnel



**USV provided radiation detection in small-boat drive-by with real-time expert reachback; network-controlled USV & UGV**

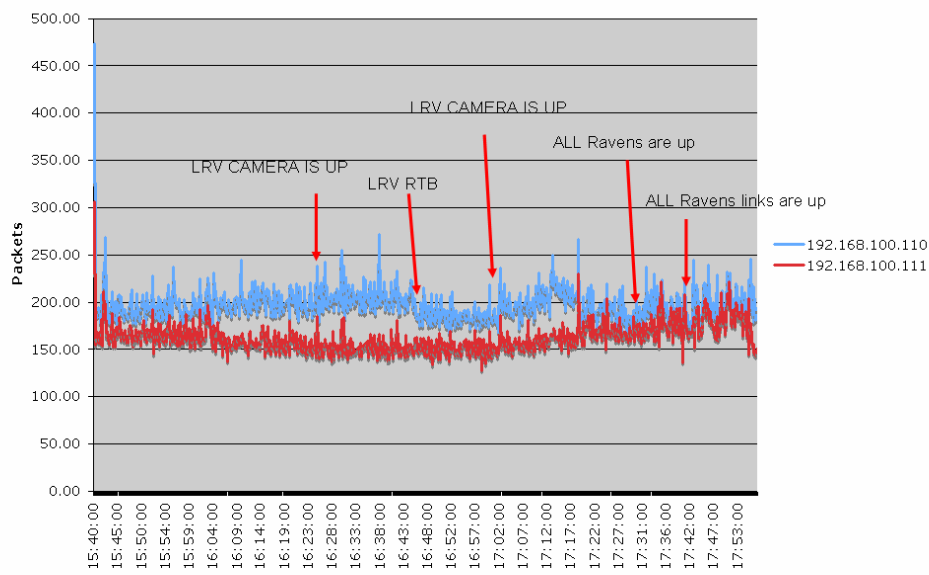


# MIO Testbed Operation Challenges: NOC Response

View of the tactical wireless  
OFDM 802.16 link behavior

View of Performance and Fault  
Management Monitors

NOC TO HILL



	Response Time	Packet Loss	Status	Since last change
UAV	606 ms	0 %	Node Up	10 minutes
2.168.101.185	284 ms	0 %	Node Up	13 minutes
2.72	125 ms	5 %	Node Up	7 minutes
92.168.199.2	354 ms	0 %	Node Up	14 minutes
.73	1 ms	0 %	Node Up	32 minutes
2.71	260 ms	0 %	Node Up	6 minutes
UAV	no response	100 %	Request Timed Out	1 hour, 29 minutes
2.74	no response	39 %	Request Timed Out	1 minute
	5 ms	0 %	Node Up	9 hours, 47 minut...
	1 ms	0 %	Node Up	2 hours, 15 minut...
18.99.121	4 ms	0 %	Node Up	2 hours, 15 minut...
2.168.99.33	4 ms	0 %	Node Up	2 hours, 15 minut...
IP: 192.168.102.1	1 ms	0 %	Node Up	2 hours, 15 minut...
192.168.99.38	3 ms	0 %	Node Up	2 days, 6 hours, ...
68.99.31	3 ms	0 %	Node Up	9 hours, 16 minut...
71	no response	100 %	Request Timed Out	31 hours, 45 min...
168.99.38	no response	100 %	Request Timed Out	3 hours, 4 minutes
192.168.99.37	no response	100 %	Request Timed Out	3 hours, 4 minutes
168.99.118	no response	100 %	Request Timed Out	2 days, 7 hours, ...
.74	no response	100 %	Request Timed Out	28 hours, 53 min...
.75	no response	100 %	Request Timed Out	28 hours, 37 min...
nt Laptop 192.168.99.183	0 ms	0 %	Node Up	1 hour, 13 minutes
2.73	no response	100 %	Request Timed Out	24 hours, 22 min...
92.168.101.198	no response	100 %	Request Timed Out	27 hours, 34 min...
1.72	no response	100 %	Request Timed Out	31 hours, 45 min...
	1 ms	0 %	Node Up	16 minutes

Raven 4  
Fast Ethernet Controller (3C905C-TX Compatible) - Packet

Receive: 0 bps  
Transmit: 0 bps

Min Bps: 0 bps at 04:45 PM  
Max Bps: 493 Kbps at 04:51 PM  
Current bps: 0 bps  
Bandwidth: 100 Mbps

Raven 3  
MS TCP Loopback interface

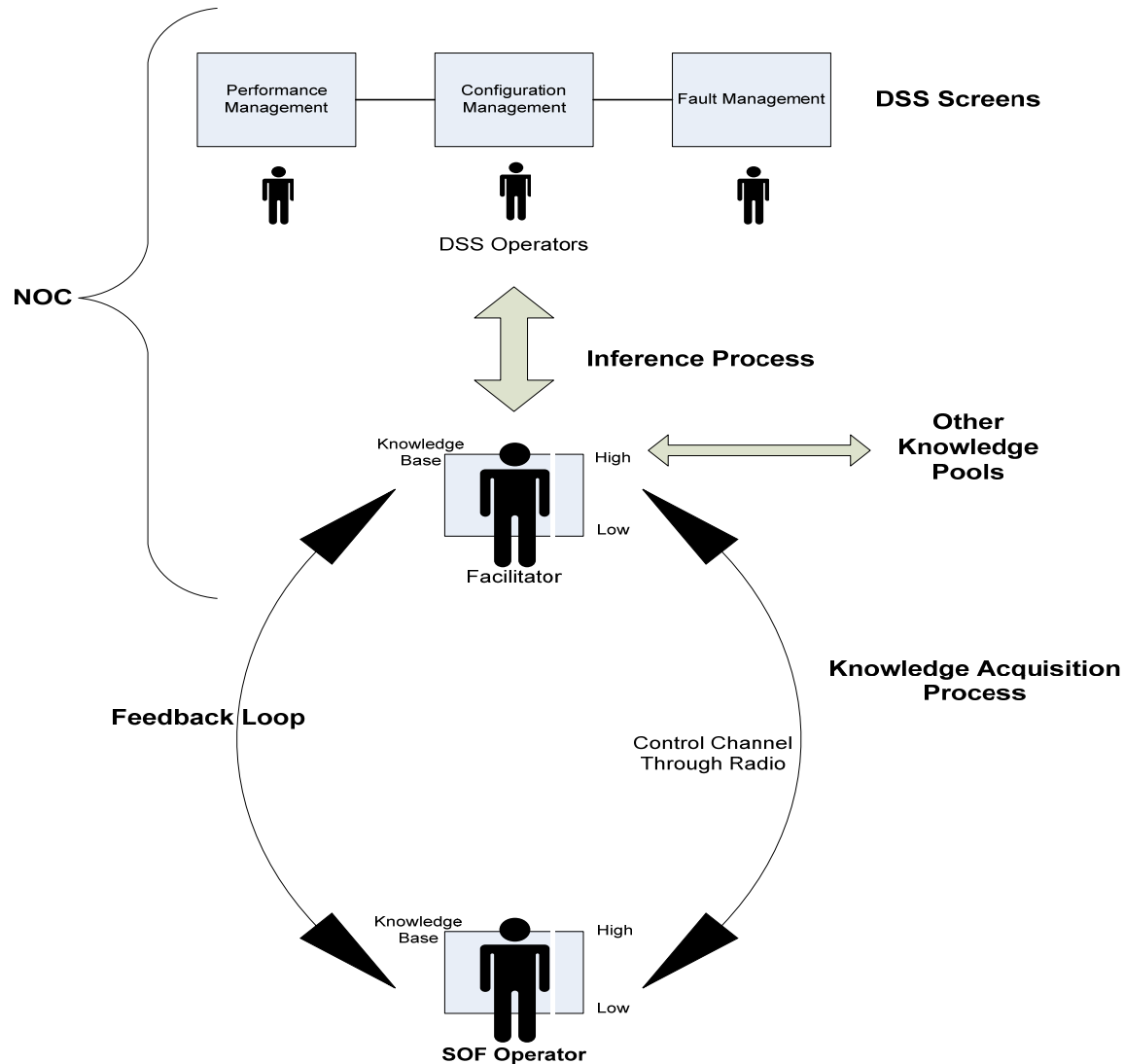
Receive: 0 bps  
Transmit: 0 bps

Min Bps: 0 bps at 04:45 PM  
Max Bps: 596 Kbps at 04:47 PM  
Current bps: 0 bps  
Bandwidth: 10 Mbps

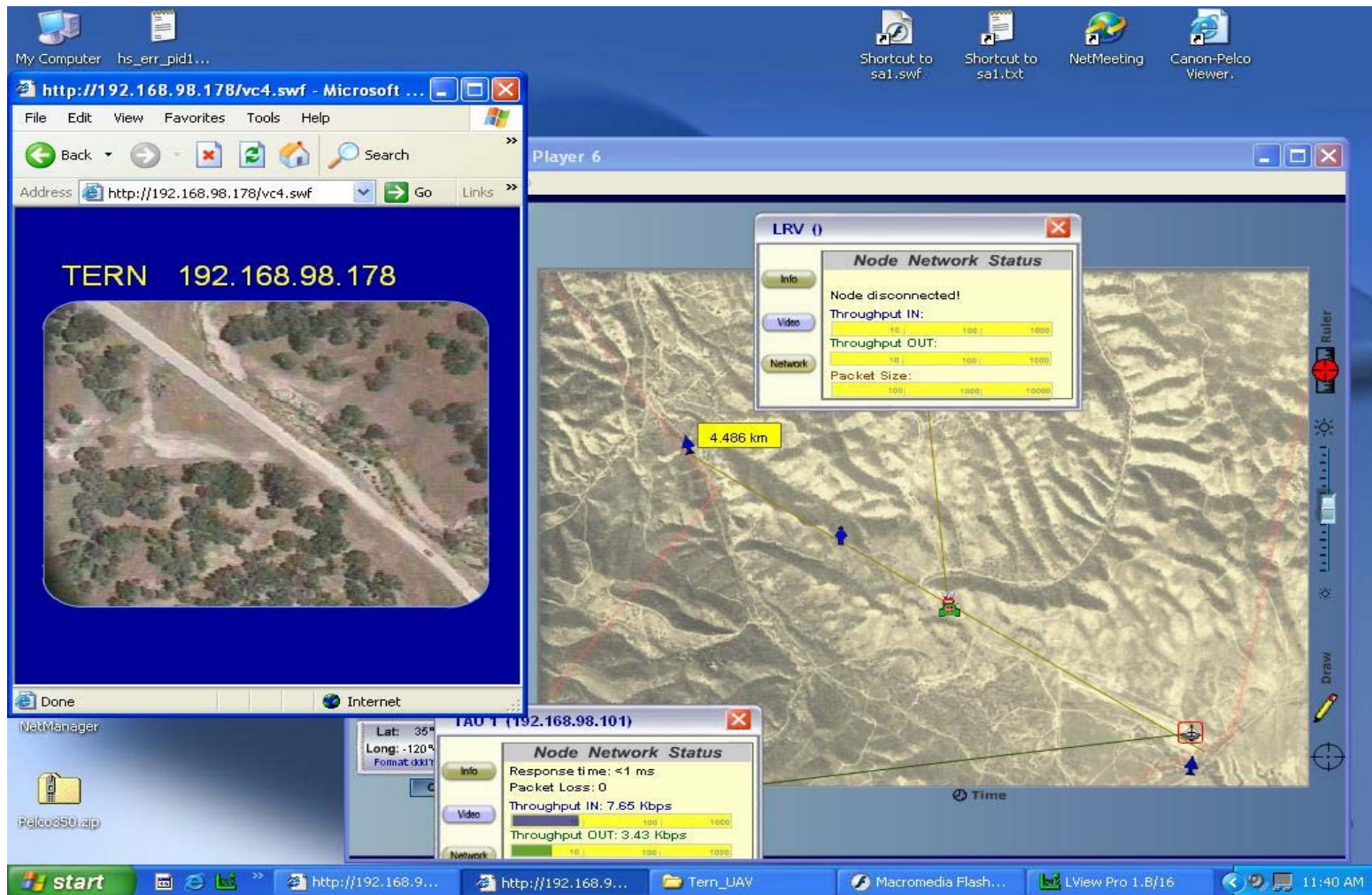


# NOC Adaptive Management Model: Facilitator/Coordinator Feedback Loop

**Model of Tactical Network Operations Communication Coordinator**



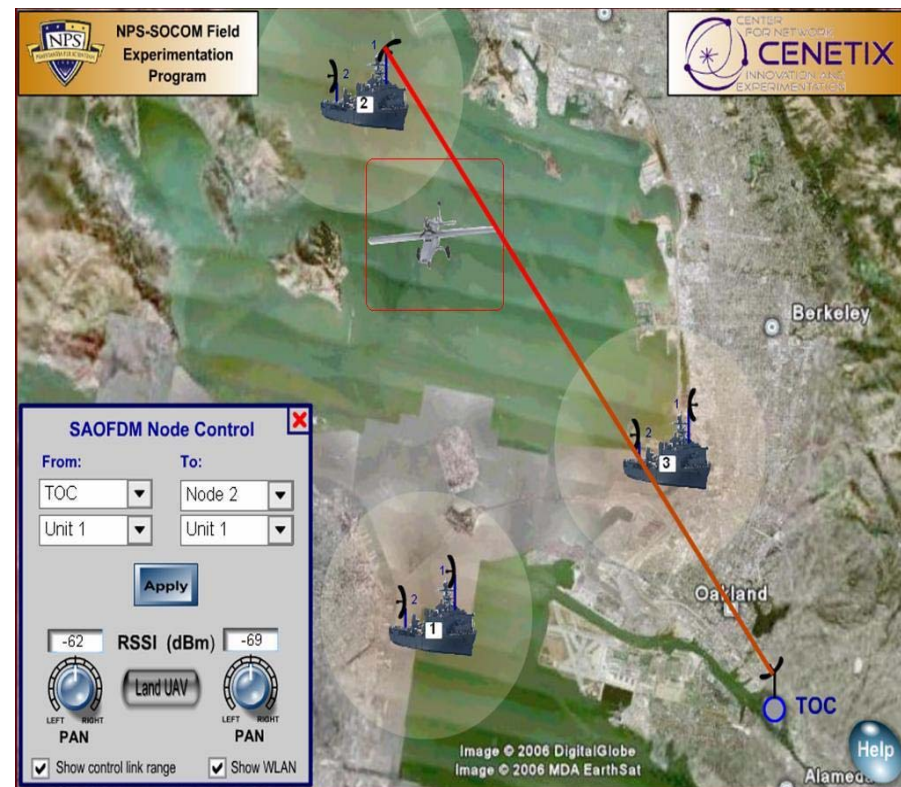
# Network-aware nodes in UAV-based HVT operations: mapping SNMP data into the SA view





# Adaptive Networking at the Situational Awareness Interface Level: Network-on-Target

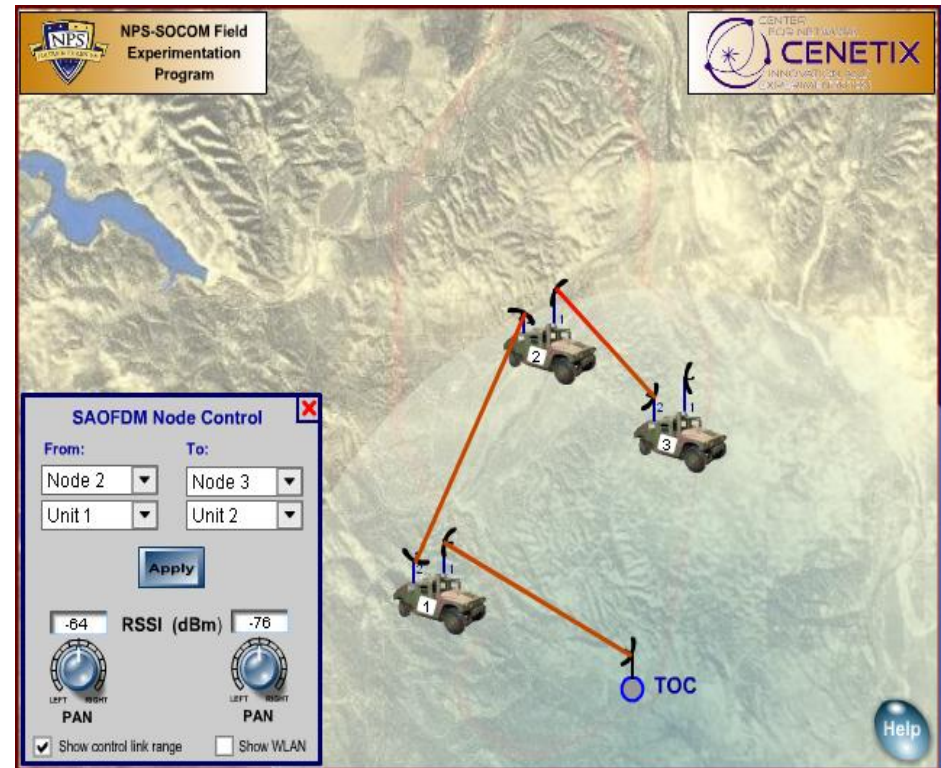
- The NoT process starts at the level of Situational Awareness Interface used by the local or higher echelon commander, to point onto the Target, which in this case is the site to be reached by the self-configuring network
- In response the mobile networking node, i.e. small boat, light reconnaissance vehicle, or operator are moved to the area to extend the tactical mesh
- If the site is too far, or the preceding links are about to break down, the UAV is deployed to stretch the network further to the remote most node, or to heal the overstretched intermediate link





# NoT at Work : Remote and Self-Alignment of Broadband Point-to-Point Antennas

- This in turn would require rapid and frequent re-alignment, of the antenna assets including panel switching and tune-up decisions made right at the level of local commander situational awareness view
- More so, the commander's remote advisers, located thousands miles away of surveillance and targeting area would be able to see the effects of the healing assets deployment in the Situational Awareness view and assist the commander in re-aligning and stretching the mobile network to the target area



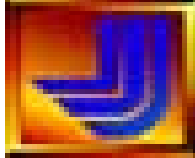
# NoT (SAOFDM Solution) at Work



SAOFDM\_MIO.swf

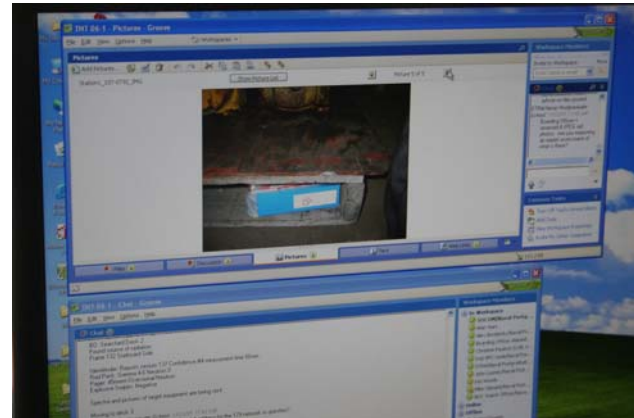


# Collaborative Technology



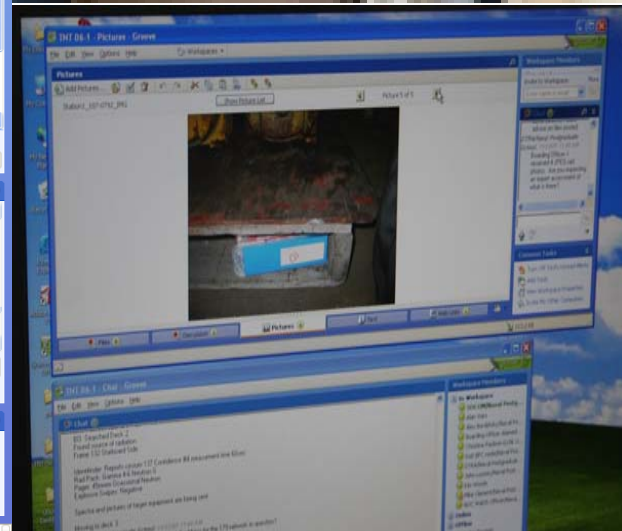
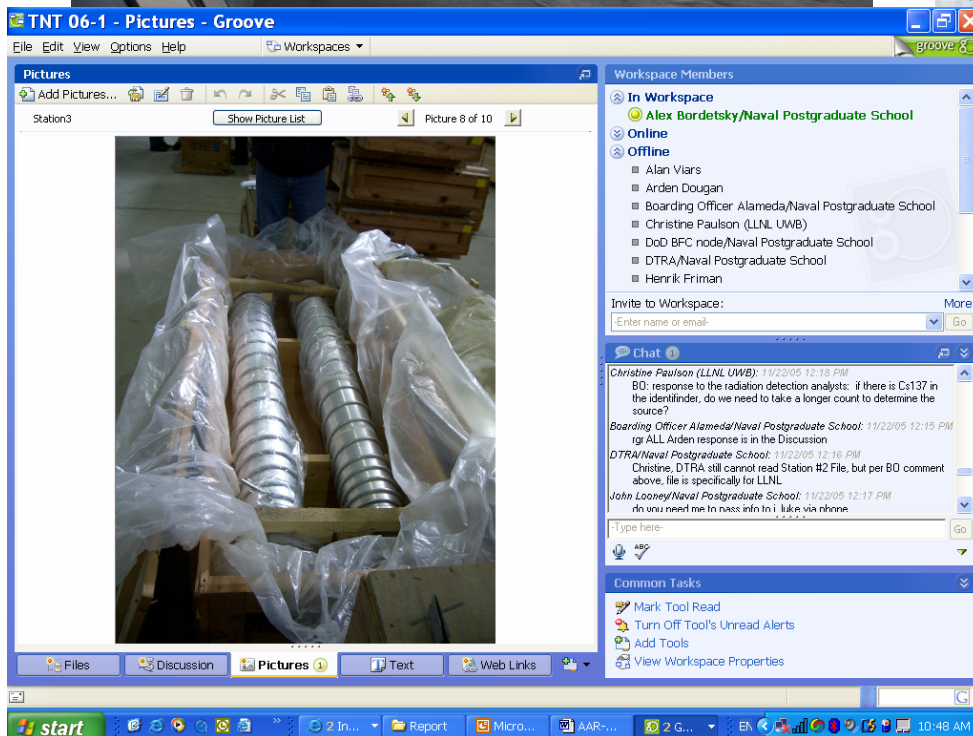
# Geographically Distributed Collaborative C2 and Data Fusion Environment

Distributed team of  
Experts and Command  
Officers: Mobile  
Command Post (C2 input),  
DTRA (machinery  
smuggling), LLNL  
(radiation detection),  
SOCOM (ops advice)





# Boarding Party Self-Synchronization with TOC and DTRA in Groove



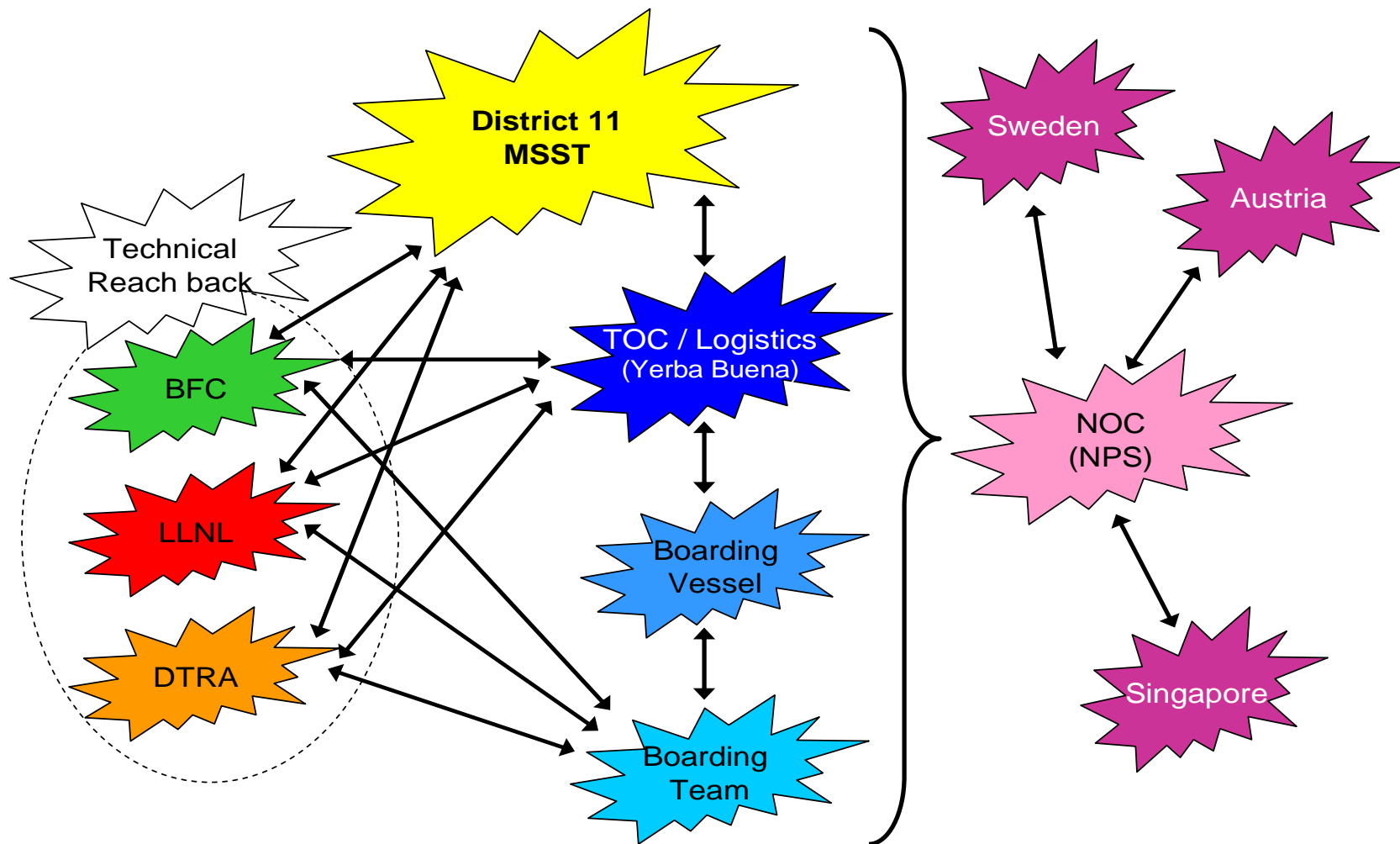


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**TNT MIO 06-4 : Feasibility of using innovative self-aligning broad band wireless solutions to support boarding and target vessels on-the-move, boarding party real time collaboration with coalition partners and first responders**

**(August 30-September 1, 2006)**

## MIO 06-4 Collaborative Network







# Participating Units

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## **NPS**

Class on Collaborative Technologies

Network Operations Center and Data Collection site via groove

Network Support team and Experiment Control (act as back up to make all necessary inject should network connectivity problems exclude certain players).

## **Swedish Team**

Maritime Security Office of the Port of Oakland

observing and supporting experiment control by scenario injects made via groove, SA, and by video feed (with CDR Leif Hansson in Lead)

## **Austrian Team**

Port of Hong Kong (where the containers were loaded)

observing and supporting experiment control by scenario injects made via Groove, SA, and by video feed (with Dr. Ulrich Hofmann in Lead, Ulrich Wagner as Technical POC)

## **Team in Singapore**

Shipper of the cargo containers

observing and supporting experiment control by scenario injects made via Groove, SA, and by video feed (with Dr. Yu Chiann in Lead)

## **DHS Science & Technologies CounterMeasures Test Beds**

Office of Emergency Services

Assists CalOES and DOE RAP





# Participating Units

---



**Alameda County Sheriff's Office Marine Patrol Unit Boat and RHIB**– Boarding vessel, deploys boarding party and does drive by (carries IST detector)

**Oakland Police Boat 35** the target vessel

**OFT Stiletto Ship**-remote early warning command post en route to San Diego area

**USCG**

District 11 Watch Officer

PAC Area Watch Officer

MSST Level Two capable boarding team with radiation detection equipment?



# Participating Units

---



## **LLNL**

Providing source, source security, and data files for detection teams (if necessary)

Providing remote analysis cell from Livermore via Groove

Provide mapping facility of bay showing critical facilities (HOPS), radiation detection reachback and atmospheric modeling reachback

LLNL Watch Officer – remote cell (operating from NPS)

2 members of Boarding Party (with radiation detectors)

## **BFC (Biometrics Fusion Center)**

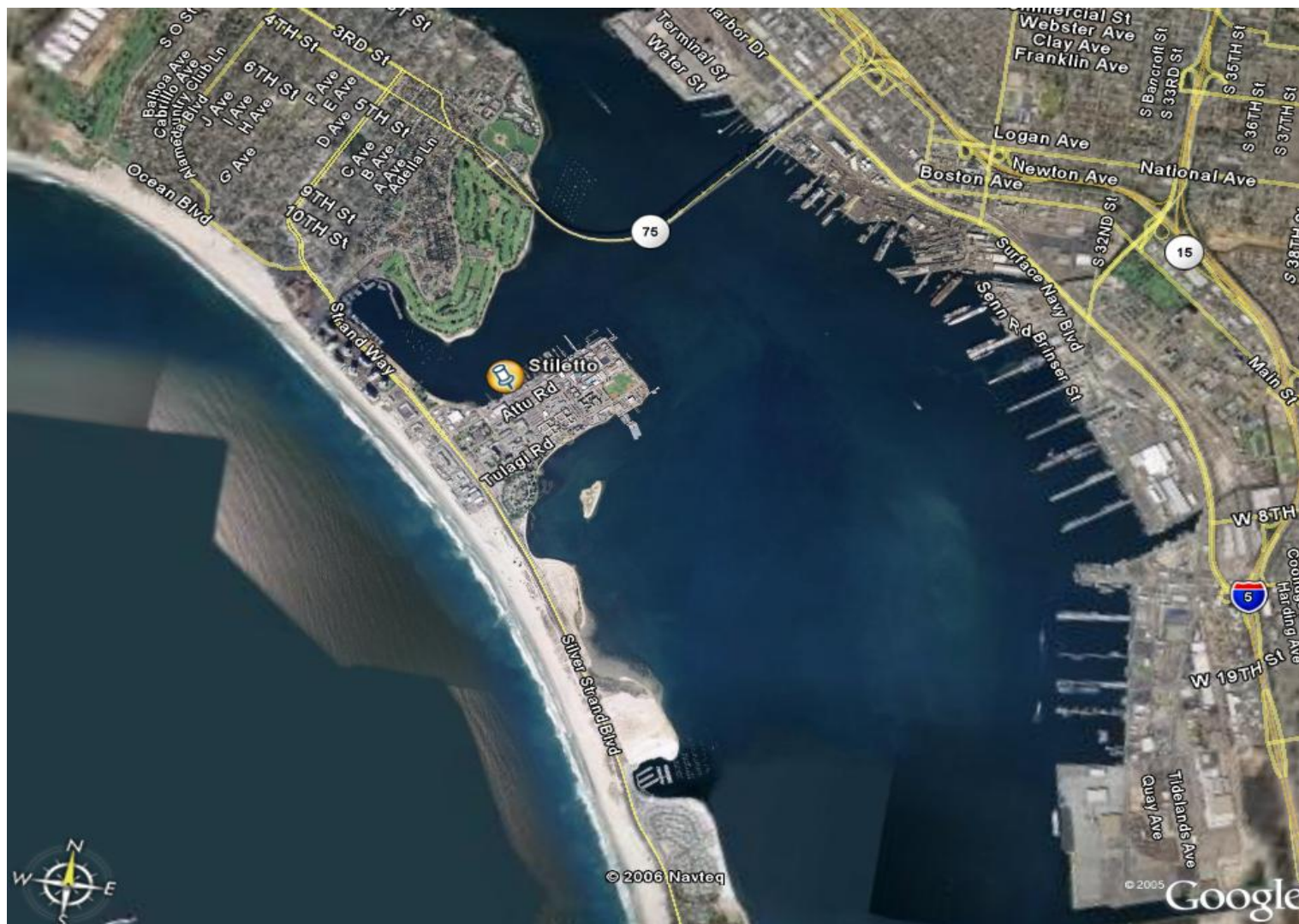
Providing data files for detection teams,

Providing remote support for exercise database search and results reporting via Groove collaborative software

## **SOCOM Observers**



# Remote Navy Asset: OFT Stiletto Ship in San Diego






# Boarding Party Situational Understanding Development via Collaboration with Expert and Command Remote Sites

TNT-MIO District 11 - Pictures - Groove

File Edit View Options Help Workspaces

Pictures

Add Pictures... Show Picture List IMG\_1211 Picture 7 of 11



Workspace Members

- Henrik Friman
- James Gateau/Naval Postgraduate School
- Jeff Withee/Naval Postgraduate School
- John Looney/Naval Postgraduate School
- Jonas Hedlund
- Leif Hansson
- LLNL Export Control
- LLNL Export Ctrl/Naval Postgraduate School
- LLNL Observer/Naval Postgraduate School
- LLNL Reachback 2/Naval Postgraduate School
- LLNL reachback/Naval Postgraduate School
- LLNL Watch Officer
- LLNL WO2/Naval Postgraduate School
- Mark Laherty/Naval Postgraduate School
- MIFC/Naval Postgraduate School
- Nita Miller/Naval Postgraduate School
- Pacific Area/Naval Postgraduate School
- Peter Guest/Naval Postgraduate School
- Randall Simmons/Naval Postgraduate School
- Russell Dash/Naval Postgraduate School
- SFPD MU/Naval Postgraduate School
- ShippingCompany
- Stiletto1/Naval Postgraduate School
- tnt06singapore1
- tnt06Singapore3

Invite to Workspace: More

Enter name or email Go

Chat

Common Tasks

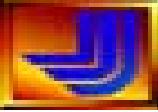
- View By
- Suppress All Alerts
- Set Roles
- Send Message to Members

Files Disc... We... P. Sket... Cale... Mee... We... Pict... Tas...



# Getting Drive-by Search Feedback from Sweden





# Source Detection Feedback from Singapore

TNT-MIO District 11 - TNT 07-1 (01-Dec-06) - Groove

File Edit View Format Options Help Workspaces

### TNT 07-1 (01-Dec-06)

New Topic Response

Date	Subject	Author
12/1/06 12:19 PM	Re: OAK PD Boat posted RAD files from SF tgt vessel drive-by	LLNL Reachback 3/Naval Postgraduate School
12/1/06 12:37 PM	Re: OAK PD Boat posted RAD files from SF tgt vessel drive-by	NGO User 1/Naval Postgraduate School
12/1/06 11:58 AM	Plume Model	LLNL WO
12/1/06 12:27 PM	Wind direction	Peter Guest/Naval Postgraduate School
12/1/06 12:38 PM	Re: Wind direction - plume	John Crandley
12/1/06 12:28 PM	Boarding Officer -status aboard Target Vessel	Boarding Officer_YBI/Naval Postgraduate School
12/1/06 12:31 PM	M/V Sheik of Oman arrives in Singapore	MIFC/Naval Postgraduate School
12/1/06 12:33 PM	Re: M/V Sheik of Oman arrives in Singapore	Singapore1
12/1/06 12:35 PM	Re: M/V Sheik of Oman arrives in Singapore	Singapore1
12/1/06 12:54 PM	Re: M/V Sheik of Oman arrives in Singapore	LLNL Reachback 3/Naval Postgraduate School
12/1/06 12:41 PM	Singapore Radar ranges	Peter Guest/Naval Postgraduate School
12/1/06 1:15 PM	chemicals found	LLNL WO2/Naval Postgraduate School
12/1/06 1:27 PM	Re: chemicals found	Arden Dougan
12/1/06 1:41 PM	FINEX	D-11 WO

**Re: M/V Sheik of Oman arrives in Singapore**  
by Singapore1 on Dec 1, 2006 12:33:31 PM Modified on Dec 1, 2006 12:35:56 PM

Radiation detected!

Radiation data files posted in TNT 07-1 Singapore folder.

LLNL radiation reachback requested, please.

Note that singapore video feed is not operational.

Workspace Members

**In Workspace**

- Alex Bordetsky-N...

**Online**

**Offline**

- 214
- ACM Unit 1/Naval Po...
- ACME/Naval Postgra...
- Alan Viars
- Alex Bordetsky/Naval...
- Anders Kihlberg
- Arden Dougan

Invite to Workspace: More

Enter name or email- Go

**Chat**

Is he [Dave T] swimming home?

D-11 WO: 12/1/06 1:37 PM  
any answer to my question about plutonium versus potassium for the fertilizer? (event #17)

Arden Dougan: 12/1/06 1:40 PM  
see my answer in discussion

Type here- Go

**Common Tasks**

- Mark Tool Read
- Turn Off Tool's Unread Alerts
- Add Tools
- View Workspace Properties

Files TNT ... Task Manager Web Links Pictures Pictures TNT06-4 TNT07-1 (3... 1.47 KB





# EWall Integration with Groove: Combining Biometrics Identification (NBFC row), Radiation Detection (LLNL row) and Groove events at the distributed locations (Alerts row)

**EWall NewsView**  
File View Help Client updated at 11:49 AM Server updated at 11:49 AM Running for 0 hours Showing 200 stories in 71 cards Using 32 MBytes

**11:49 AM**

Category	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
<b>BIO Officer</b>	 SA: 20:59:09 updated.									
<b>TELEMASTER</b>										
<b>NBFC</b>	 SA: 10:13:23 updated.	 SA: 10:13:14 updated.	 SA: 10:13:12 updated.	 SA: 10:13:02 updated.	 SA: 08:22:39 updated.	 SA: 08:22:36 updated.	 SA: 08:22:34 updated.	 SA: 08:22:21 updated.	 SA: 08:22:10 updated.	
<b>LLNL</b>	 SA: 14:55:04 updated.	 SA: 14:54:59 updated.	 SA: 14:54:54 updated.	 SA: 14:53:20 updated.						
<b>Alerts</b>	 SA: 8/31/2005 4:20:51 PM Notes: Link to Pelican	 SA: 8/31/2005 3:57:12 PM Notes: 17 kilometer link	 SA: 8/31/2005 3:53:40 PM Notes: Had Pelican video	 SA: 8/31/2005 3:44:17 PM Notes: Pelican Flight	 SA: 8/31/2005 3:16:10 PM Notes: Pelican showed	 SA: 8/31/2005 9:43:36 AM Notes: Tern passes	 SA: 8/31/2005 9:40:05 AM Notes: LRV1 system	 SA: 8/31/2005 9:37:05 AM Notes: All equipment	 SA: 8/31/2005 9:34:59 AM Notes: Network goes	 SA: 8/31/2005 9:28:10 AM Notes: Network goes

Downloading from site: <http://www.google.com/> Internet

Start | D:\InetPub\wwwroot\Ne... | Google - Microsoft Intern... | EWall NewsView | 11:50 AM



# MIO 06-4 Findings



- SAOFDM-based experimental adaptive on-demand ship-to-shore network provide expected connectivity and level of bandwidth capable of carrying on several video streams and data sharing situational awareness applications. While on the move at speeds 3-5 nm/hour and zigzag maneuvering of the Boarding Vessel trying to chase the Target, the SAOFDM node by using designed self-aligning algorithm applied via the control channel enabled to keep ship-to-shore directional link intact, providing transmission rates up to 5 Mbps.
- Collaborative technology (shared workspaces, SA, video tools) performed well, enabling simultaneous radiation detection and analysis taking place in different geographically distributed locations.
- We observed successful SA integration with early drive-by detection of radioactive source on board of truck in Bavarian Alps (upper right view), by the first time in action Stiletto ship in San Diego (lower right view) and plum detection of the boat in SF Bay (lower left view). For the first time three surface nodes and three overseas command posts (Swedish Navy, Singapore DTSA, and Austria (Salzburg Research) acted together with District 11 (CG), YBI TOC and NPS NOC.

# **Tactical Network Topology Maritime Interdiction Operation Experiments: Enabling Radiation Awareness and Geographical Distributed Collaboration for Network-Centric Maritime Interdiction Operations**

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**December 5-8, 2006**

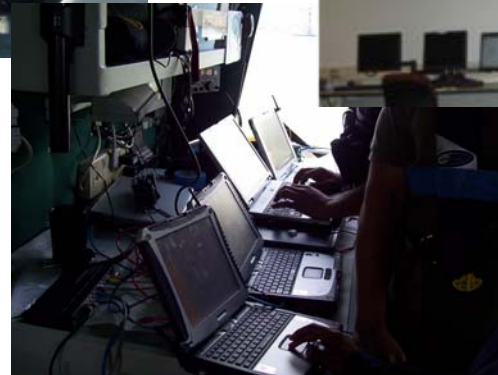
**Arden Dougan**

**International Maritime Domain Security Symposium**

# TNT Maritime Interdiction Operation Test Bed



- **Tests cutting edge technology for WMD detection and communications in maritime environment**
  - Communications in harsh environments, between moving ships at sea
  - Netcentric collaboration with global partners
  - Situational Awareness
  - Scenario-based

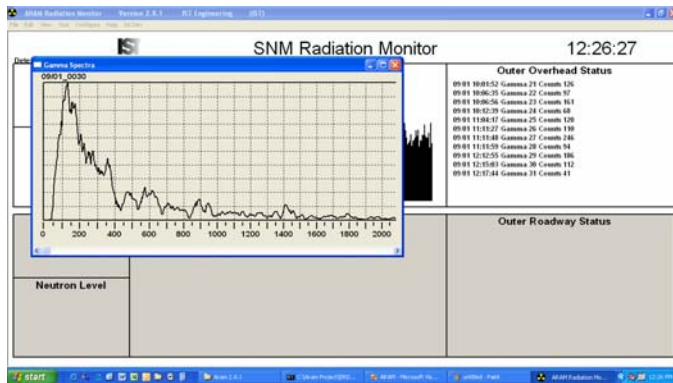




# Drive-By Radiation Detector: ARAM – Adaptable Radiation Area Monitor



- Real time radiation monitoring system
- Spectral data analyzed to quickly provide actionable information
  - flow of commerce not impeded
  - secondary search possibly not necessary





# Radiation Sources used in TNT

- **Naturally occurring radioactive materials (NORM)**
  - Radium smoke detector
  - Thorium lantern mantles
  - Calibration Sources
  - Moisture gauge
- **Surrogates**
  - Fiestaware
  - Uranium-238
  - Plutonium surrogate



# Surrogate Radiation Sources used to simulate special nuclear materials



- **Plutonium surrogate**
  - Mimics Pu for 1<sup>st</sup> response detectors
  - DOT Limited and Excepted Quantity for easy transport
  - Field life 2-3 months (renewable)



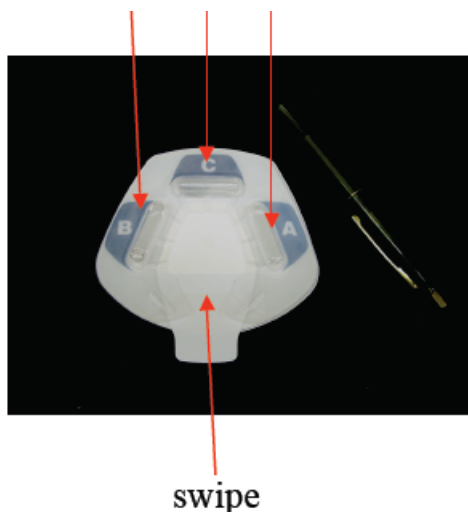
# Explosives detection kit - ELITE



- Colorimetric explosives detection system
- Simple to use swipe test, immediate results, requires little training
- Detects over 25 explosives and their precursors
- Low nanogram detection limits
- Swipes and tests potentially contaminated areas
- Enables easy detection of color change

## ***LITE detects:***

- ***nitro aromatics (including TATB)***
- ***nitrate-esters***
- ***nitramines***
- ***picric acid***
- ***inorganic nitrate compounds***



- Small, disposable, one use system
- Easy to use, no training required
- Minimized heating requirements
- Uses a swipe material for improved sampling
- Inexpensive to manufacture
- Detects aromatic, aliphatic, and nitrate explosives
- Utilizes three types of chemical reactions
  - Meisenheimer complex
  - Griess Reagent
  - Zinc reduction of nitrates

- **Radiation Experts**
  - Analyze radiation spectra
  - Determine quality of data
  - Ask for additional information (background spectra, photos)
- **Consequence Analysts**
  - Plume modeling
  - Access to maps, atmospheric modeling, hazardous chemicals database
- **Export Control Experts**
  - Analyze photos of items
- **Emergency Response Coordinators**
  - Advanced planning (direct movement of ships, area vulnerabilities, etc.)

# Examples of Radiation Reachback



**Who:** unknown

**What:** A truck loaded with an cargo container

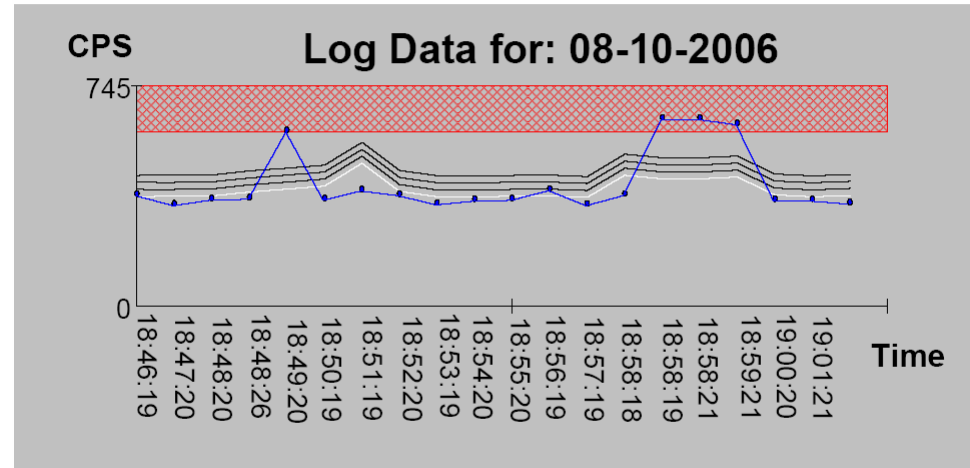
**When:** A time ago (exact time unknown)

**Where:** Entrance into the Hong Kong seaport

**How:** Portal monitor

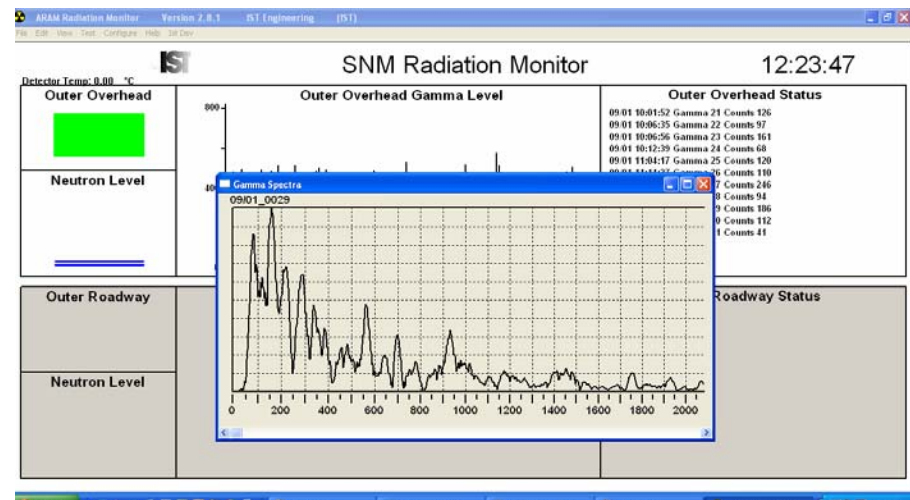
**Specials:** No neutrons observed, just gamma radiation

## Radiation Alarm



## Hong Kong Border

There is one item that was added to CalMart's shipment, not normally part of their shipment. This item is sent by George Koncher to the "Citizens Against Nuclear Things."





# Plume Modeling

Request worst case scenario for vessel carrying materials listed above.

Current location is 37-47.04N 122-21.28W. winds from SW



# The TNT MIO Node in Singapore

*Dr Foo Yu Chiann*

*Project Manager*

*Defence Science and Technology Agency*

# Experiment Set-up



- 3 wireless laptops connected via 802.11g to the Internet
- Location:



- The Singapore node is connected to the MIO collaborative environment through a Virtual Private Network (VPN) established between DSTA and NPS.



# Video Feeds

*Stiletto*



*Boarding Vessel*



*TOC*



*Sweden*

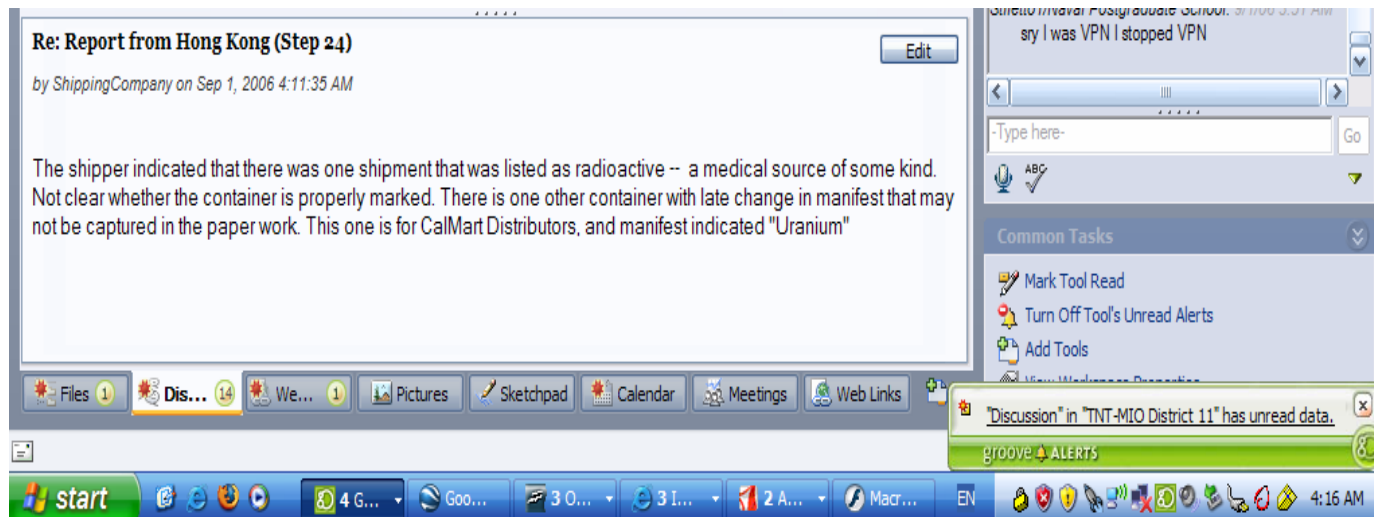


*Austria*



# Role for MIO-06

- Singapore played the role of the shipping company that had unknowingly transported the radioactive cargo (via Port of Hong Kong) as part of its shipment
- Provided the shipping manifest of the cargo containers to Port of Hong Kong and MIFC to aid investigations





# Role for MIO-07

- Simulated the boarding & search of a vessel that may have a nuclear device
  - Radiation profile and photo of the suspicious item sent via collaborative environment for reachback analysis at LLNL

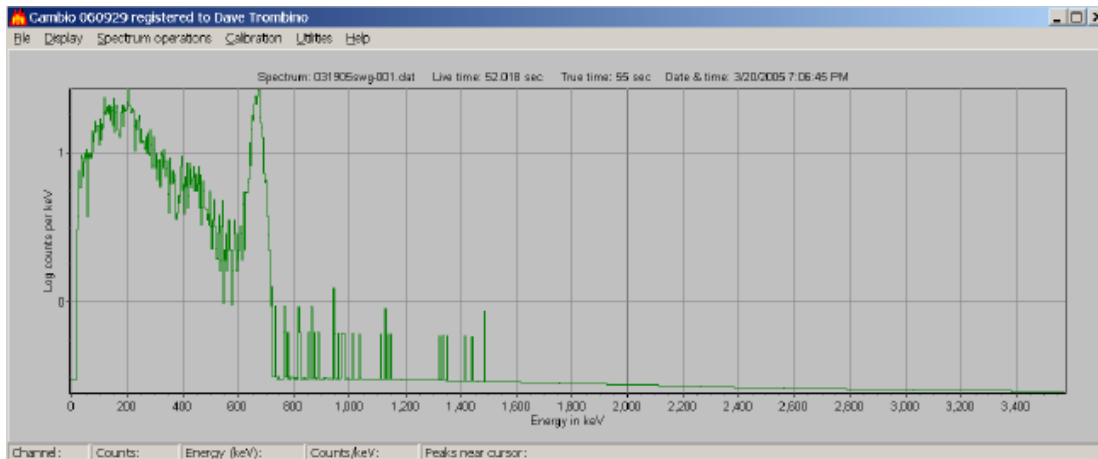


Figure 9-9. Moisture Gauge

# Observations

- The Experiments have provided insights on the possible new operational capabilities that could be achieved with collaborative networking
  - Allow boarding team immediate access to remote expertise during boarding operations
  - Shorten decision-making processes
- Way ahead
  - Explore how such collaborative technologies could be applied for our own operations

# Swedish Naval Warfare Centre

Wireless Broadband supporting Maritime  
Security in Littoral Waters



FÖRSVARSMAKTEN  
SJÖSTRIDSSKOLAN

# TNT 07-1

Sweden acted as a counterpart MIO agency, conducted the same operations and exchanged real time information that was analysed by the reachback organisation.

Radiation data (provided by the CBRN centre)

Calculated radiation spread (provided of the CBRN centre)

Live video feed

Observer at SF Bay



TOC



FÖRSVARSMAKTEN  
SJÖSTRIDSSKOLAN



# TNT 07-1

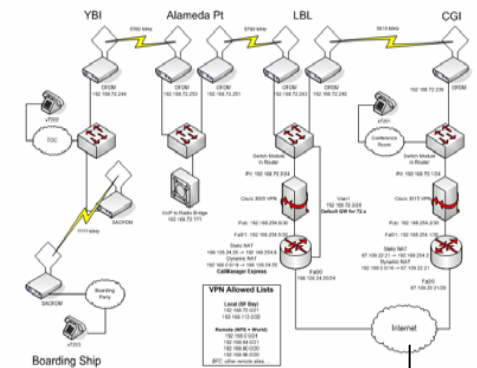
## Result:

## Connectivity with all participants

## Posted files where analysed

## Video feed to/from all participants

# VPN connection LAN-to-LAN



SNWC

## CBRN centre

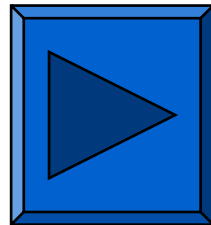
BP



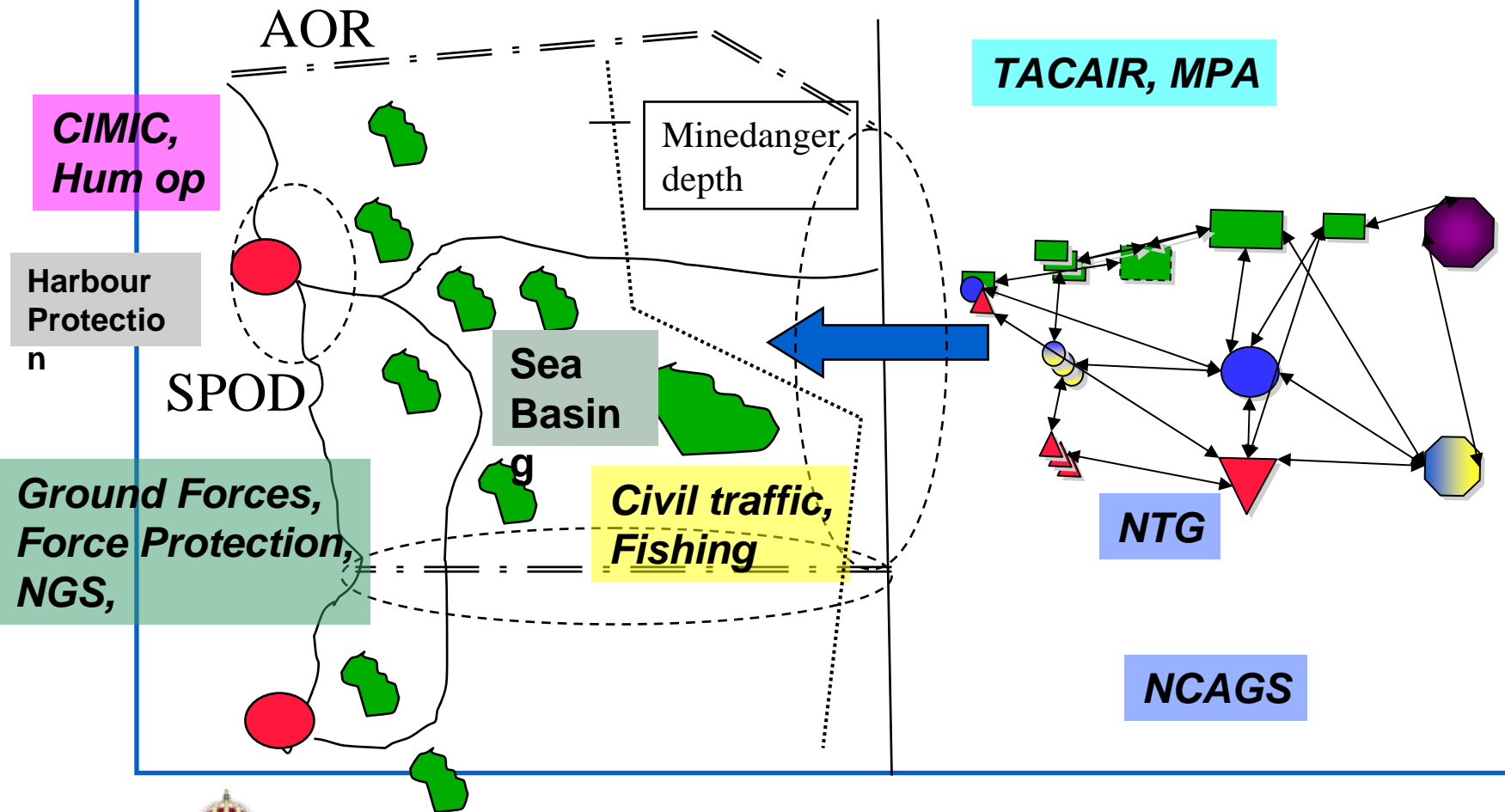


# **The Swedish goal for participating in the TNT experiments**

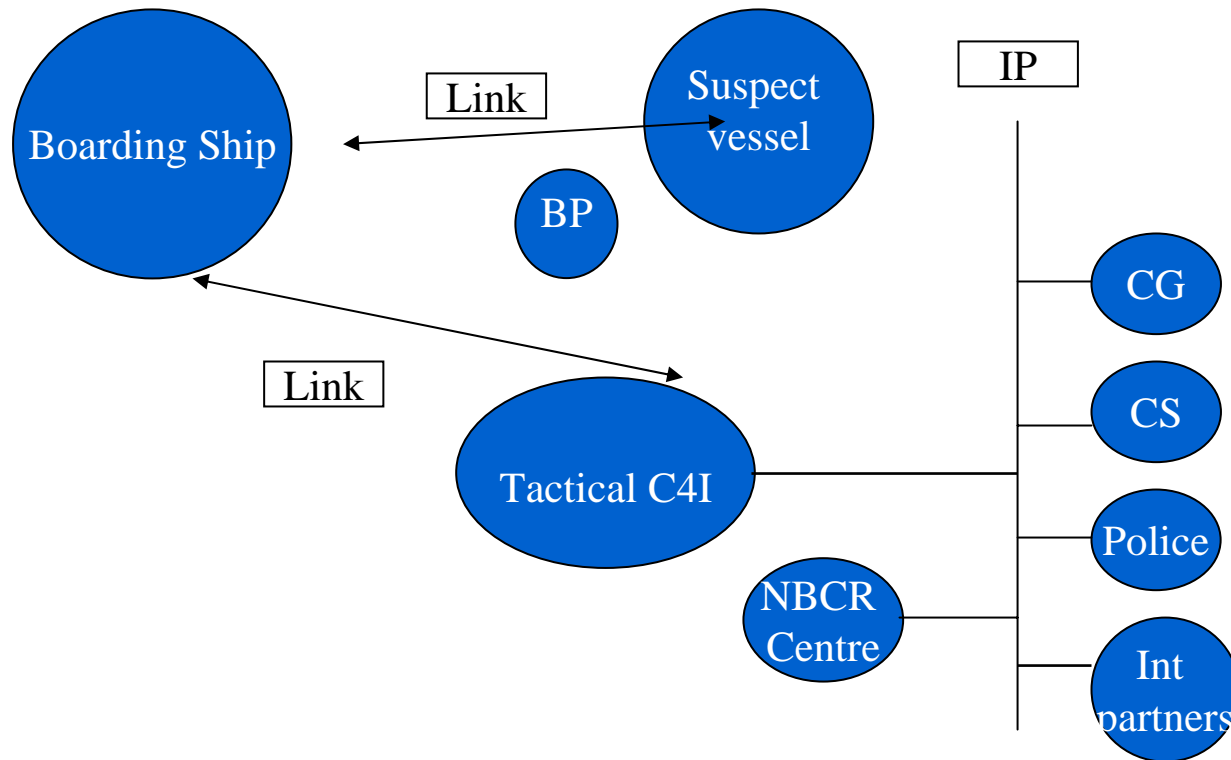
- **Use the experiments as stepstones to be able to conduct the Swedish TNT experiment fall 2008**



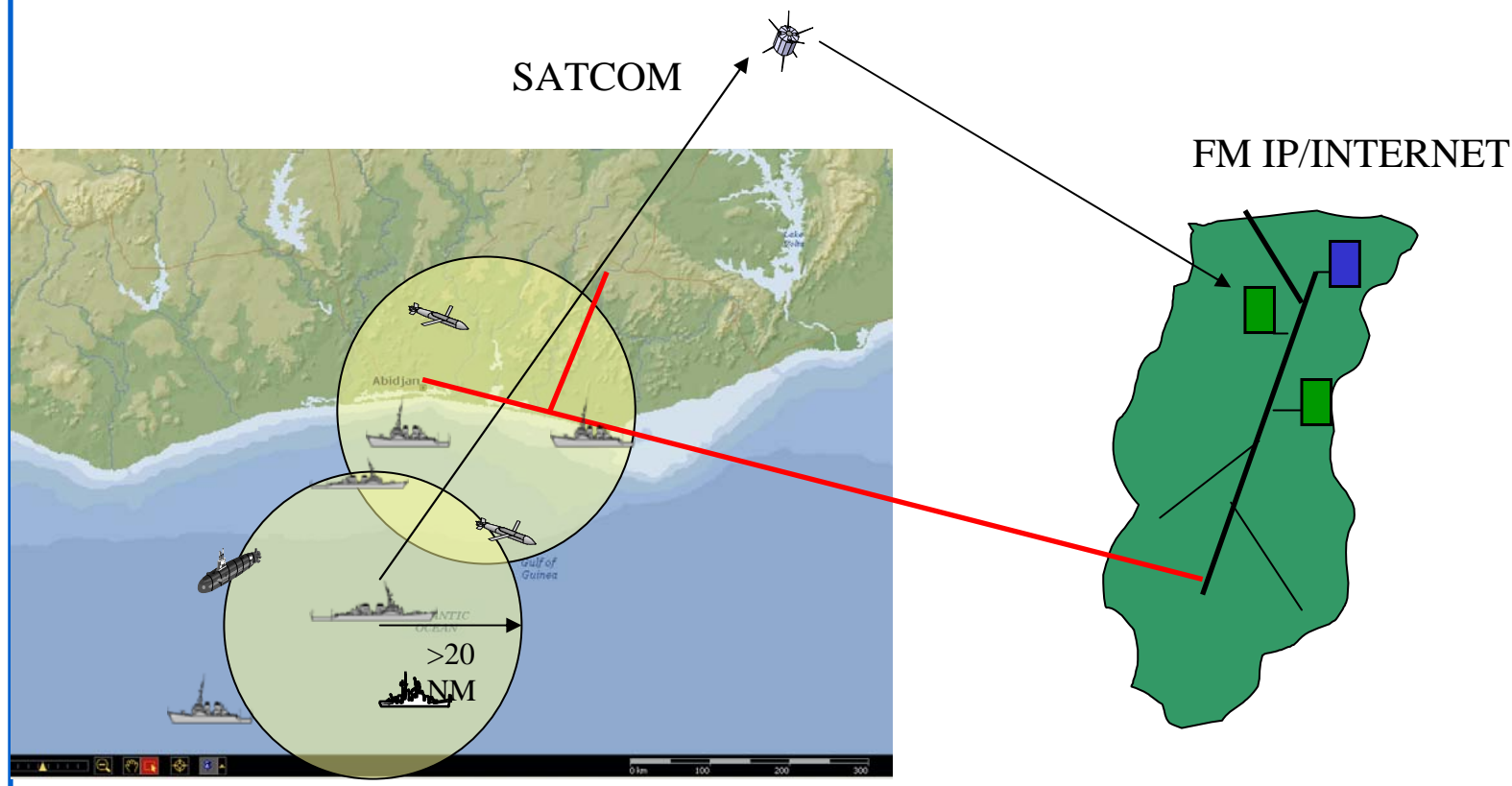
# Swedish Operational Concept - Maritime Security



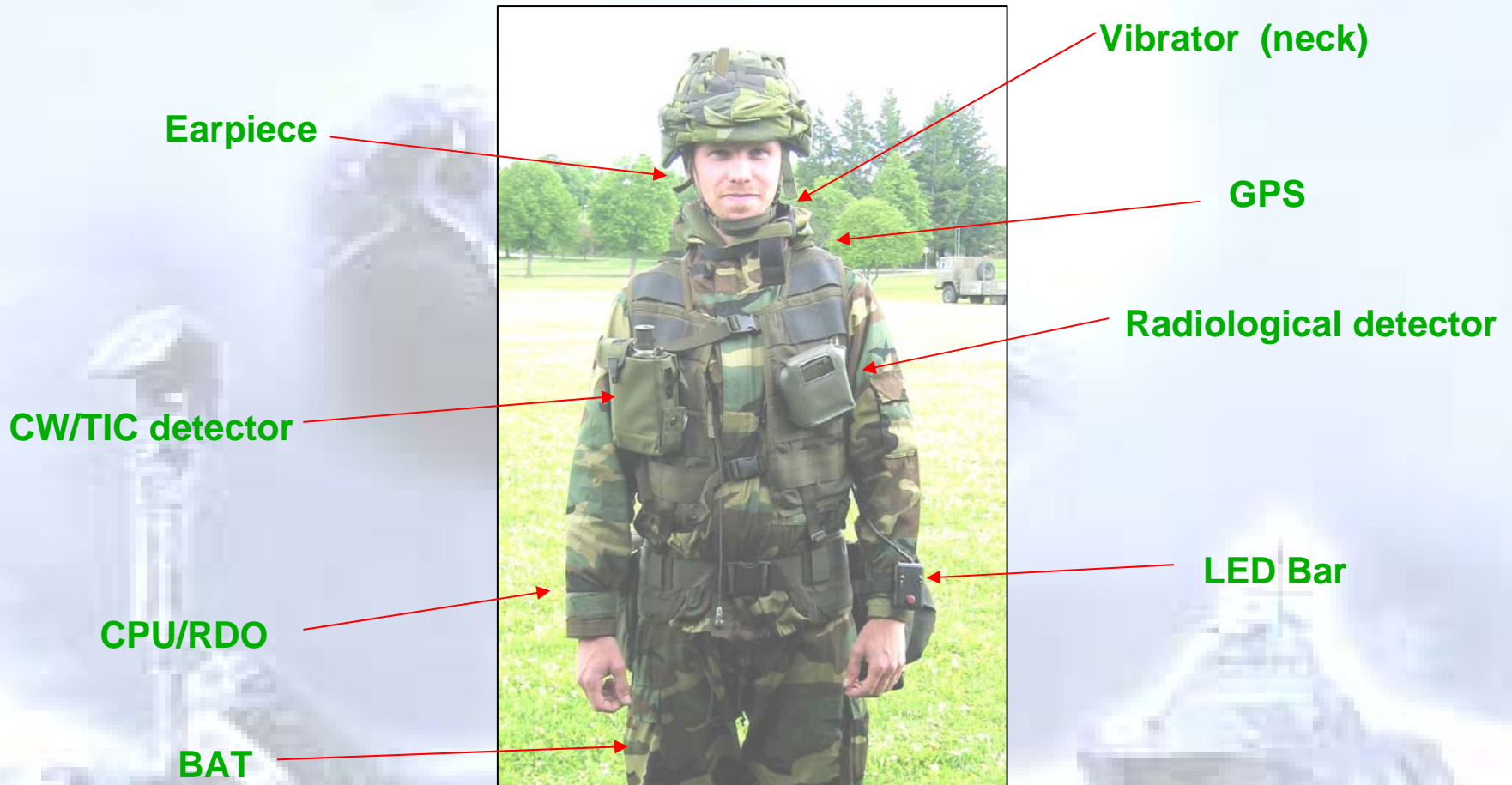
# Vision for Swedish TNT experiment fall 2008



# Wireless Broadband supporting Maritime Security in Littoral Waters



# Sensor and communication jacket



Demonstration vest developed in collaboration  
with Combitech and the University of Umeå

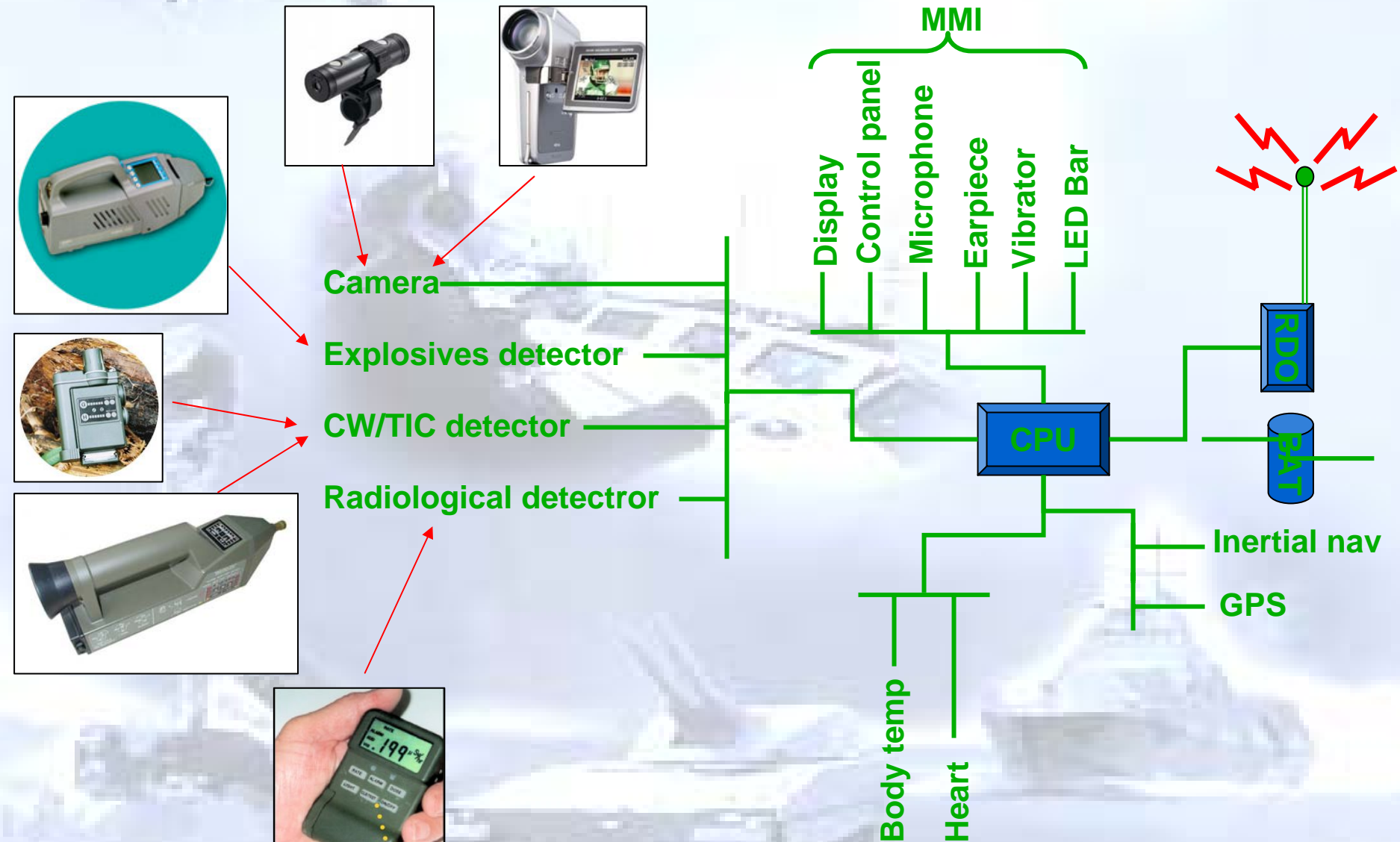


# Sensor and communication jacket

## Key features:

- Real time communication of voice, data and sensor information
- Integrated in the combat suit (jacket)
- Adapt sensors to the specific mission/task
- Possibility to supervise physiological status and position of the soldier
- Presentation of alarm and data to the soldier (MMI)

# Sensor and communication jacket





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**Questions?**